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Front cover: Wild Daffodils *Narcissus pseudonarcissus* growing in an ancient woodland in South Yorkshire (see p65). *Photo: Joyce Simmons*

Back cover: *Sphagnum* recovery on Black HIll in 2017 (see p5). *Photo: Bridie Hamilton*

The Naturalist

Editorial

The Naturalist does not often include Editorials but there are two reasons for including one in this issue. Firstly, the Editorial Board would like to apologise for the later-than-usual delivery of the January *Naturalist*. The YNU membership database, from which *The Naturalist* mailing list is derived, had to be transferred to a new system and this has taken considerably longer than anticipated, as is often the case with IT-based projects! We are extremely grateful to Clare, our Membership Secretary, for the time and effort she has put in bringing the transfer to a successful conclusion.

Secondly, the range of material submitted for publication varies considerably and it is an unusual occurrence to receive three articles on a single taxon, quite independently of each other. This has happened in the case of *Sphagnum* and it has been decided to include all three in this issue. Mark Hoyle and colleagues have been looking at changes in the *Sphagnum* communities of Ilkley Moor over the past 50 years, Bridie Hamilton and colleagues have been comparing active reintroduction of *Sphagnum* with natural recolonisation as approaches for restoring degraded blanket bog in the southern Pennines and Steven Heathcote has been looking at the rather unusual context of a small *Sphagnum* mire at Cromwell Bottom, in the Calder Valley. In addition to these we have a review of Clifton Bain's timely new book - The Peatlands of Britain and Ireland: A Traveller's Guide. While naturalists and archaeologists have been aware of the significance of peat bogs and the threats to them for some considerable time, it's only relatively recently that their value in terms of flood alleviation, carbon storage and sequestration have been recognised more widely. A Government consultation on the banning of peat from amateur horticulture closed on 18 March so it is, perhaps, apposite that this edition contains three articles on *Sphagnum*, a key taxon in the formation of peat bogs.

A comparison of reintroduction and natural recolonisation by *Sphagnum* on degraded blanket mire

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Introduction

Blanket bog is classed as a priority habitat under the EU Habitats Directive and there are c.25,000km^2 in Britain. Indeed, Tallis (1998) noted that 95% of blanket bog within the UK is designated as a Site of Special Scientific Interest (SSSI) or Special Area of Conservation (SAC). These mires are extremely diverse habitats and provide numerous ecosystem services such as water filtration and carbon sequestration, with peatlands globally storing 30% of all land-based carbon (Maddock, 2008). The *Sphagnum* mosses are keystone species central to the ecological functioning of bog habitats. They sequester more carbon in temperate and northern ecosystems than any other vegetation and *Sphagnum* mosses can hold up to 20 times their weight in water. They decompose slowly under anoxic conditions to form peat (Carroll *et al.*, 2009).

However, only 4,000km^2 of Britain's blanket bogs are still in a state approaching a natural condition; with 74% being degraded and classed as in either unfavourable health or unfavourable recovering health (Anderson, 2016). The Dark Peak has a particularly long history of ecological damage, with modification to blanket bog areas occurring since the 1300s with an estimated 80 million cubic metres of peat being removed for fuel use (Ardron, 1999).

Intensive degradation has also resulted from widespread drainage of areas of moorland for livestock grazing. This has caused a transition of vegetation to dry heathland, as wet bogs are unsuitable for livestock grazing and can result in the animals developing foot rot (in the case of sheep) or becoming mired. This also makes the areas more suitable for Red Grouse *Lagopus lagopus scotica* shooting as Heather *Calluna vulgaris* becomes increasingly dominant and there may be associated managed burning. In areas such as the South Pennines there is also the adverse impact of gaseous and particulate air pollution from nearby industrial and urban centres. During the 1970s and 1980s there was a tenfold increase in anthropogenic SO_2 emissions that fell as acid rain on the neighbouring countryside (Mylona, 1996). Core samples analysed from Bleaklow (SK0925495938) and Kinder Scout (SK0851787520) showed a correlation between the increase of soot contaminants in the upper 10cm of the surface peat deposits and the dramatic decrease of *Sphagnum* around this time (Tallis, 1988). Increased concentrations of sulphuric acid within the peat have led to displacement of calcium, magnesium and potassium ions, resulting in increased leaching and nutrient loss and reduced pH. Between 1880 and 1991 6,400kg/ha of wind-blown sulphur from centres of industrial activity was deposited on the Southern Pennines compared to 1,580kg/ha deposited in the Northern Pennines (Carroll *et al.*, *loc. cit*).

With leaves being only one cell thick and easily damaged, *Sphagnum* mosses are extremely vulnerable to the impacts of air pollution (Thompson & Bottrell, 1998). The effects of this pollution led to the Peak District and South Pennines being described as an ecological desert for *Sphagnum* and classed as one of the most degraded areas of blanket bog within the UK (Ferguson & Lee, 1983). A loss of *Sphagnum* leads to altered hydrology with the bare peat

becoming extremely susceptible to drying and wind erosion. Over time, this reduces the water-table to below that of the acrotelm layer, making the system vulnerable to flash flooding during heavy rain events as there is no or very little vegetation present capable of holding water. A consequence of this has been the formation of large erosional gullies as throughflow and storage decreases, and surface runoff increases (Pilkington *et al.*, 2016). Drier conditions promote the growth of grasses and dwarf shrubs, further making the conditions less suitable for *Sphagnum* re-establishment and effectively creating heathland (Thom *et al.*, 2019).

Due to the severity of the ecological damage that has occurred in the Peak and the Pennines, re-establishing *Sphagnum* has been problematic. Despite *Sphagnum* dispersing long-distance by air-blown spores, it has been argued that a lack of local source material has meant that *Sphagnum* could not recover naturally in many areas even as pollution decreased and conditions improved (Caporn *et al.*, 2018). Consequently, emergency action plans were developed to deliver landscape scale restoration on degraded areas of blanket bog that were presumed to be beyond natural recovery (Carroll *et al*, 2009). A variety of propagules were developed as ways to reintroduce source material: plugs, clumps and beads with gel have all been used. Survival monitoring trials showed effectiveness of 99%, 36%, and 0-12% respectively. However, cost is also an issue with plugs the most expensive at £10.44/m^2 per degraded bog area, clumps at £3.15/m^2 and beads and gel at £1.04/m^2; cost-benefit analysis indicates that clumps were the most effective at £9.00/m^2 of established *Sphagnum*. Nevertheless, due to the lack of donor material and worries over the potential impacts on donor sites, plugs were taken forward as the main propagule method (Caporn *et al.*, 2018).

The content of the main *Sphagnum* propagule used in restoration has differed between sites. Black Hill, the first Moors for the Future Partnership (MFFP) site to be restored, was predominately planted with beads containing Flat-topped Bog-moss *Sphagnum fallax* as it was the first species available in propagule form. Often used as one of the main species of *Sphagnum* in reintroductions, *S. fallax* is described as a pioneer species due to it being more tolerant to lower pH and higher nutrient levels (Hayward & Clymo, 1982). This is an effective way to quickly establish *Sphagnum* cover but can result in a high density of a single species becoming dominant. *Sphagnum* can occupy a variety of niches so a diverse mix of species can be found in a healthy blanket bog and a benefit of the plug propagule is that 11 or more moss species can be contained within the plug (Table 1). This potentially produces a more diverse *Sphagnum* cover rather than a predominance of one species (Caporn *et al.*, 2018). However, there are concerns that diversity within reintroduced *Sphagnum* areas will only increase if the different species within the plug are able to establish and colonise effectively.

Table 1. The composition of *Sphagnum* species in MFFP plug plants (Caporn *et al*., 2009)..

Sphagnum Species	**Percentage of total volume of sphagnum**		**Percentage of total volume of sphagnum**
S. fallax	20-30%	*S. subnitens*	5-10%
S. palustre	20-25%	*S. denticulum*	1-3%
S. capillifolium	8-15%	*S. magellanicum*	1-3%
S. cuspidatum	8-15%	*S. squarrosum*	1-3%
S. fimbratum	8-15%	*S. tenellum*	1-3%
S. papillosum	8-15%		

However, there are areas within the Peak where *Sphagnum* has re-established itself without the need for intervention. Studholme (1989) surveyed seventeen sites in the 1980s that had historical records of *Sphagnum* prior to its severe decline; three still had *Sphagnum*, one of which was White Path Moss on the western edge of Sheffield (Carroll *et al.*, 2009).

Vegetation trajectories produced by MFFP indicate that an initial increase in shrubs such as Heather on managed areas was due to increased nutrient input from the first stages of restoration, but this may decline as mosses become more abundant and nutrient input is lowered. (Many Pennine restoration areas were also initially restored with heather bales flown in by helicopter and spread over the bare peat. This meant an abundance of heather blown seed in the area.) Recognising how *Sphagnum* cover and species diversity vary on recovering sites and how *Sphagnum* reintroduction affects these, is therefore helpful in assessing recovery and guiding future conservation. Improved understanding can help guide further restoration and protection of UK blanket bog. This paper explores how *Sphagnum* cover and diversity differ between managed and unmanaged historically degraded upland blanket mires.

Methods

Representative study sites were selected and surveyed with 2m x 2m quadrats along carefully chosen transects. Random sampling of the area was not used as it would not provide a reliable overview of the site (Rochefort *et al.*, 2013). For each quadrat the number of *Sphagnum* species was assessed and the associated percentage cover of each evaluated. All other higher plants present were noted. *Sphagnum* guides such as the UKEconet online guide (UKEconet.org) and Liane *et al*., (2018) were used to assist identification. Site walkovers were undertaken to photograph areas rich in blanket bog species. At each site a series of detailed photographs was also taken along the route. Indicative pollutant levels were determined from analysis of bog pool samples (Table 2).

Table 2. Test method for pollutants tested from bog pool samples.

Test	Reactant Tablet	Test Method
Phosphorous	Phosphorous No1 and No2	Palintest
Ammonia	Ammonia No1 and No2	
Sulphur	Sulphate	
Nitrate	Nitratest powder and Nitricol	

Case Study 1: Severely degraded site with managed *Sphagnum* reintroduction

This site is located in the Heyden Head area of Black Hill, the most northerly of the three gritstone plateaux that dominate the Dark Peak at over 500m in elevation (Figure 1). It forms a large dome between the Longdendale Valley and the road from Saddleworth to Holmfirth and is deeply cut by three large streams within Crowden Great Clough, Crowden Little Clough and Heyden Clough (Twynham, 2019). The location of the transect line coincides with the location of early *Sphagnum* reintroduction on the site. The summit's trigonometric point known as 'Soldier's Lump' lies at 582m AOD. However, since its construction circa 1970 considerable drainage, pollution, and subsequent peat erosion have exposed the trig point foundations. The extent of peat and vegetation loss from when MFFP started work is shown (Figure 2a).

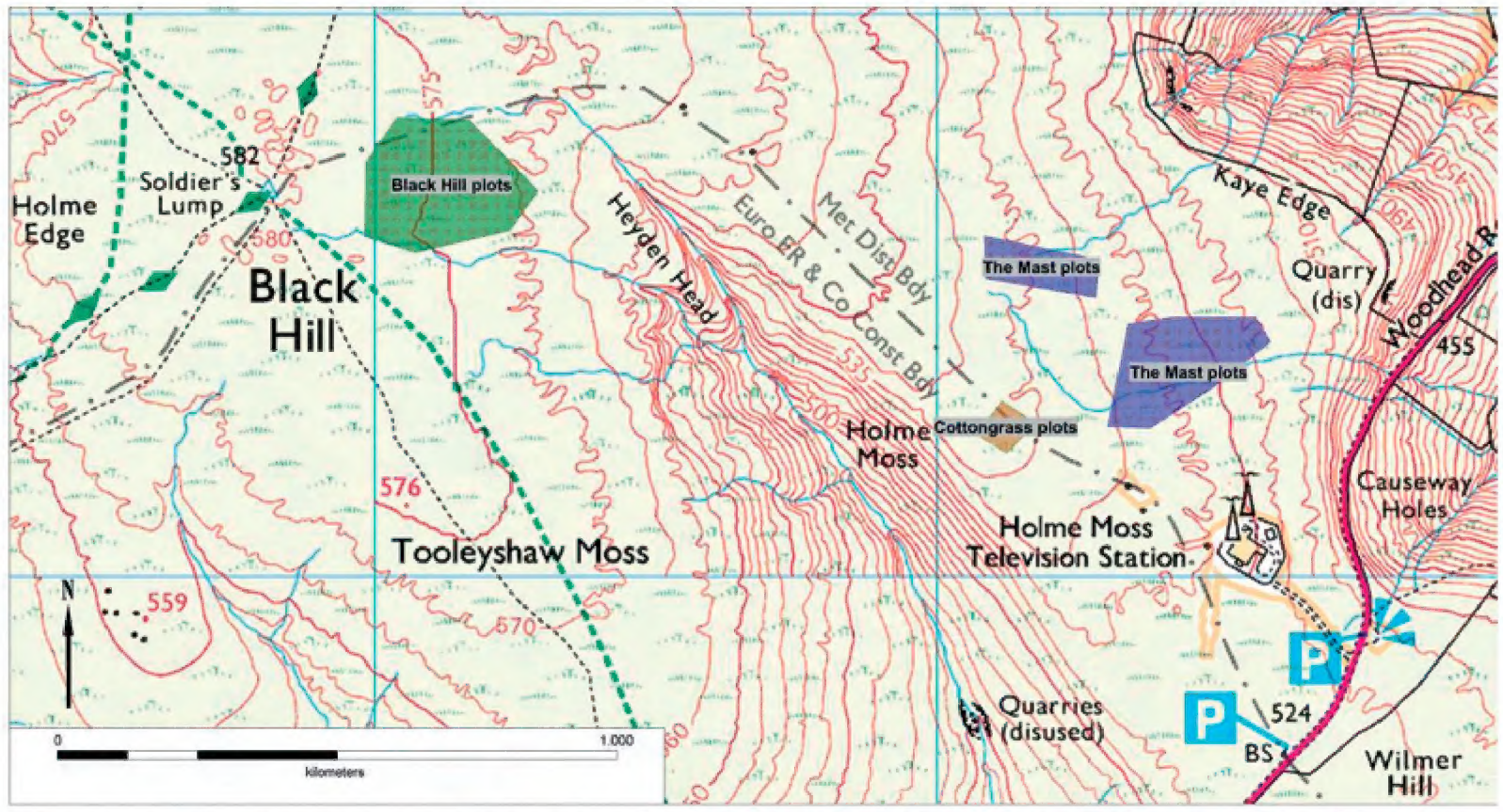

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Figure 1. The MFFP plots at Black Hill (Wittram, et al., 2015)

(2a) 2003	(2b) 2008

Figure 2. Views of Black Hill (SD 78198 36665) showing recovery. See Back Cover for an image from 2017.

The subsequent images (Figure 2b and Back Cover) show the temporal improvement after restoration where fifty million *Sphagnum* fragments were spread across the plateau (Twynham, 2019). The site runoff was also impeded through grip blocking.

Case Study 2: Previously degraded site with no management

White Path Moss located on the south-western edge of Sheffield lies at 400m in altitude and occupies a shallow depression to the north-east of Stanage Edge. A detailed investigation into this site in 1947 by Conway identified it as 'modified' blanket bog with a dominance of Common Cottongrass *Eriophorum angustifolium*. However, analysis of peat cores revealed the base for

the peat was *Sphagnum* (Tallis, 1964). A survey conducted at the time found that the dominant *Sphagnum* was *S. fallax* with a note made of the eastern area of the bog being more degraded than the western side. The only drainage outlet for the bog is Burbage Brook that cuts through the middle, running from the north-west to the south east. Bore-hole samples showed that the water table was at surface level, nearly all the existing water channels on site were younger than the main peat mass, meaning that they were man-made and had been dug for drainage purposes over time (Conway, 1947).

Gas pipeline construction during the 1970s meant a region of the south-western part of the bog was heavily disturbed and drained, encouraging dwarf shrubs to become established where the site was drier. However, Conway (*loc. cit,*) suggested that the bowl-like shape of the underlying gritstone limits the extent of drainage, encouraging peat saturation and ideal conditions for *Sphagnum* growth (Conway *loc. cit,*). No *Sphagnum* reintroduction has taken place and there has been no active restoration work or grip blocking. Perpendicular transect lines were used to place the survey sample quadrats to help assess topographic variation.

Case Study 3: Healthy blanket bog site as a control

This site is at Migneint bog on the Migneint Arenig- Dduallt SAC in North Wales. The area is fed by two main lakes: Llyn Conway and Llyn Serw. The origin of the name 'Migneint' gives clues to how rich the site is in *Sphagnum*; 'migwyn' is Welsh for *Sphagnum* and 'nant' is the name for stream so it equates to '*Sphagnum* stream'. Around 8,100 ha of the SAC is designated blanket bog, making it one of the largest blanket bog areas in Wales (Evans *et al*., 2008). Due to the scale of the site only a small area near Llyn Conway was visited. A transect route was planned based on previous site investigations over an area of the blanket bog currently classed as in favourable condition. Quadrat data were taken at the intervals shown and quantities determined from photographic evidence after returning from site. This avoids locations where past management, particularly peat cutting and drainage for agriculture, has damaged the site resulting in two thirds of the area being listed as 'in unfavourable recovering' condition (Evans *et al., loc. cit,*).

Results

Migneint had the highest total number of species at thirteen compared with ten at White Path Moss and four at Black Hill (Table 3). Migneint also had the highest number of hummock (peat-building) species. While present in small patches, there was a distinct lack of the minerotrophic species such as *S. fallax* and *S. fimbriatum* at Migneint compared to the Ringinglow and Black Hill sites where large carpets of these were present.

Only two ecological niches were present at Black Hill: carpets and aquatic carpets. *Sphagnum* ranged from 0 to 40% per quadrat (Figure 3, p8). *S. fallax* dominated with presence of Fringed Bog-moss *S. fimbriatum* in some quadrats. The small areas of Blunt-leaved Bog-moss *S. palustre* were confined mostly to the hagg tops. The first propagule to be used on Black Hill was *S. fallax* in bead form; due to their lightness these beads can easily be moved from their original planting zone by the wind. A high cover of *S. fallax* was noted in some of the surrounding gullies in the unmanaged area of the degraded upland mire on the approach to the transect site, which may be caused by this process.

Table 3. The percentage cover and *Sphagnum* species at each site.

Section	**Ecological Niche**	***Sphagnum* Species**	**Black Hill**	**Ringinglow Bog**	**Migneint Bog**
Acutifolia	Hummocks, carpets	*S. capillifolium*		x	x
		S. capillifolium subsp. *rubellum*		x	x
		S. fimbriatum	x	x	x
		S. quinquefarium			x
		S. russowii		x	x
		S. subnitens		x	x
Cuspidata	Aquatic, carpets	*S. angustifolium*			x
		S. cuspidatum		x	x
		S. fallax	x	x	x
Sphagnum	Low hummocks, carpets	*S. magellanicum*			x
		S. palustre	x	x	x
		S. papillosum		x	x
Subsecunda	Flushes, carpets	*S. denticulatum*			x
		S. inundatum			x
Total *Sphagnum* cover in the quadrat			10-20%	40-80%	>90%

Table 4. Additional vegetation species present at each site.

	Species	**Black Hill**	**Ringinglow Bog**	**Migneint Bog**
Dwarf shrub/ Graminoid	*Calluna vulgaris*	Abundant	Occasional	Occasional
	Vaccinium myrtillus	Abundant	Rare	Rare
Grasses	*Deschampsia flexuosa*	Frequent	Rare	Rare
	Eriophorum angustifolium	Occasional	Frequent	Frequent
	Holcus lanatus	Occasional	Occasional	Rare
	Molinia caerulea	Frequent	Occasional	Occasional
Other Mosses	*Campylopus introflexus*	Rare	Rare	Occasional
	Polytrichum commune	Frequent	Frequent	Occasional
Healthy Bog Indicators	*Andromeda polifolia*	Absent	Rare	Absent
	Drosera rotundifolia	Absent	Rare	Rare
	Narthecium ossifragum	Absent	Occasional	Frequent
	Vaccinium oxycoccos	Absent	Frequent	Frequent

Key to descriptors by area covered: Dominant = >70%, Abundant = 50-70%, Frequent = 25-50%. Occasional = 10-25%, Rare = <10%'

There was a high percentage of dwarf shrubs such as Heather and Bilberry *Vaccinium myrtillus* (Table 4), indicating a lower water table. The pollutant levels were the highest of all three sites (Table 5, p10) and the pH the most acidic, presumably a result of past sulphur deposition.

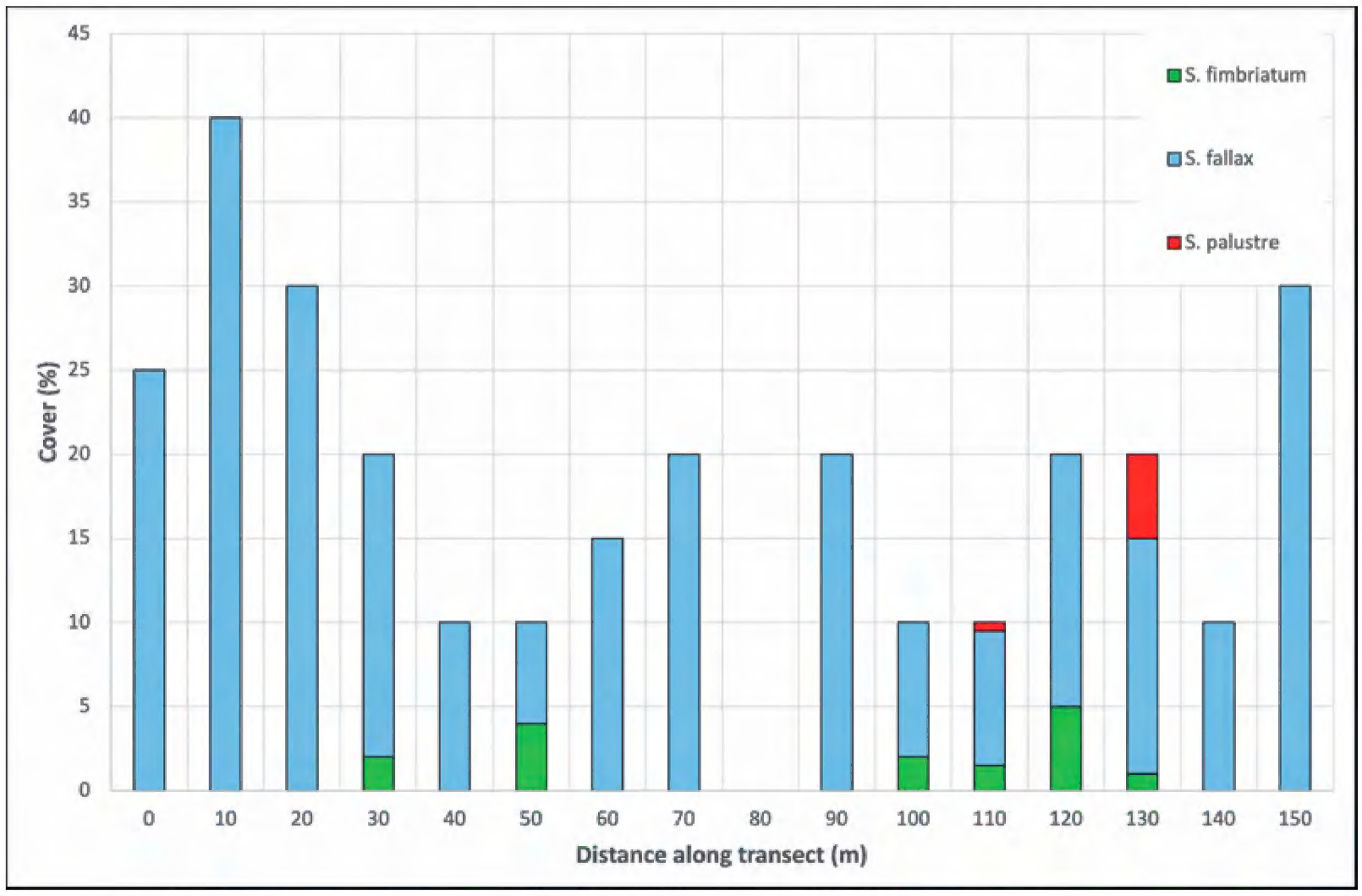

Figure 3. The *Sphagnum* cover and species at Black Hill.

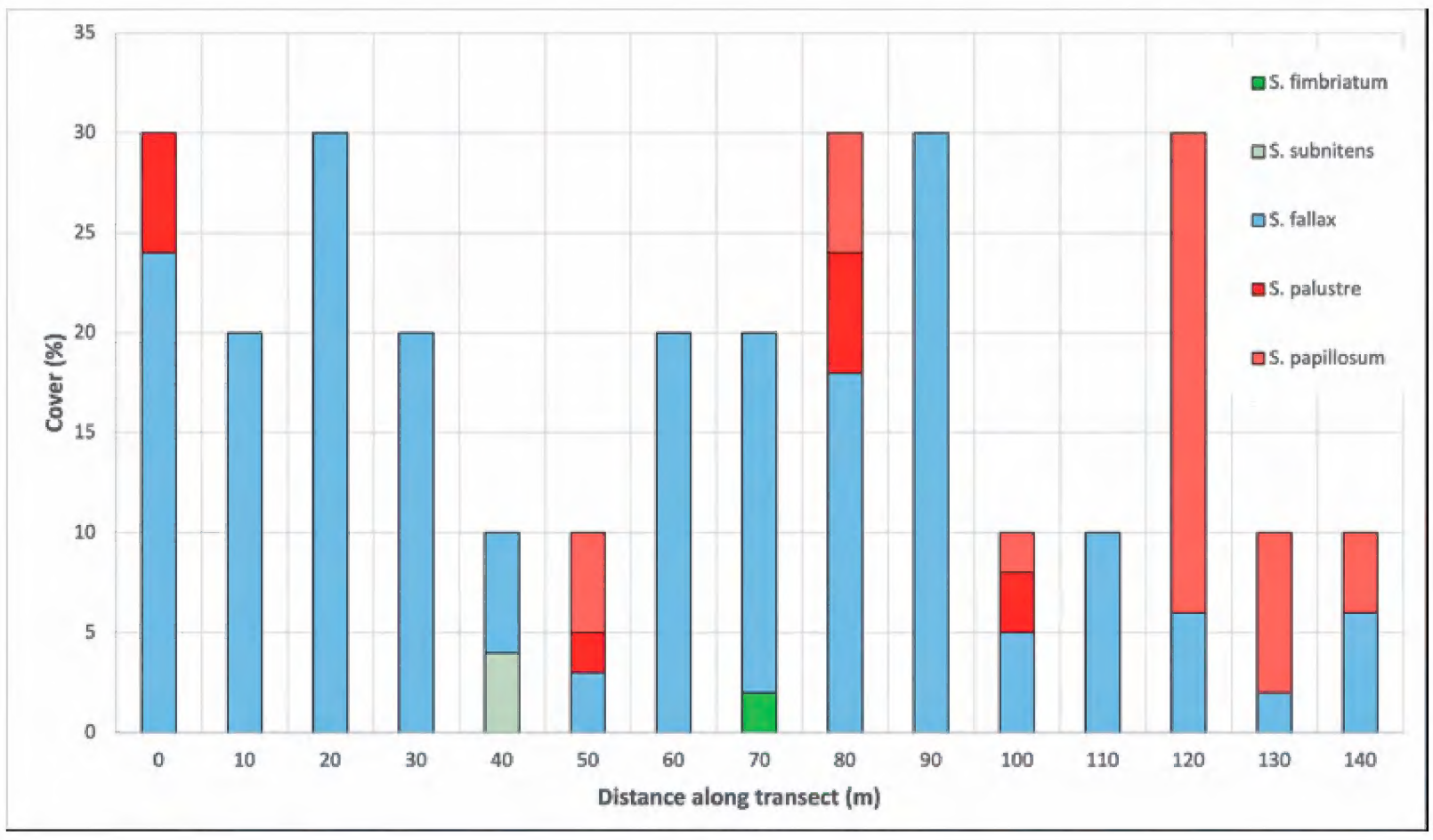

Figure 4. The *Sphagnum* cover and species at White Path Moss; vertical transect (south east to north west).

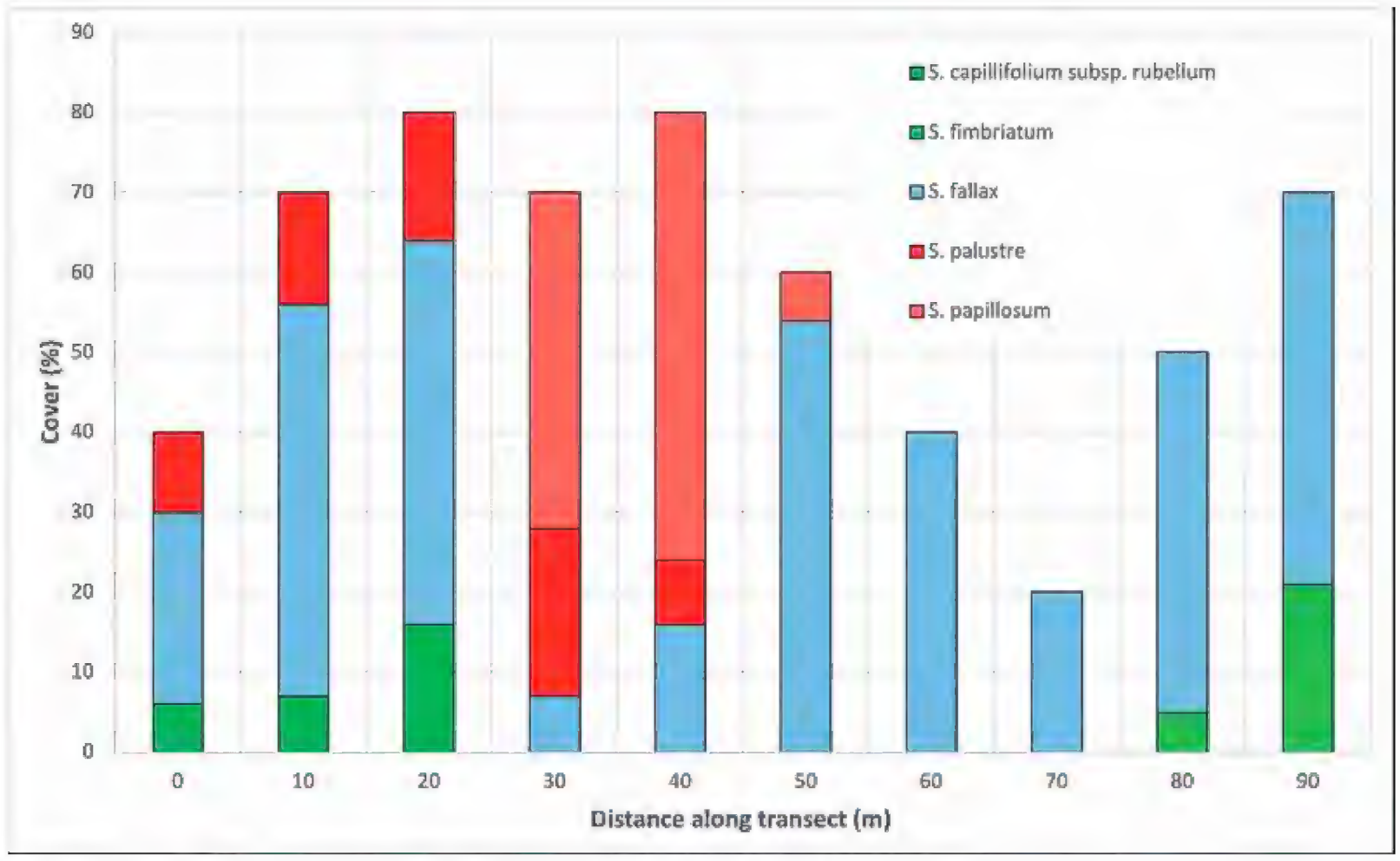

Figure 5. The *Sphagnum* cover and species at White Path Moss; northerly horizontal transect (west to east).

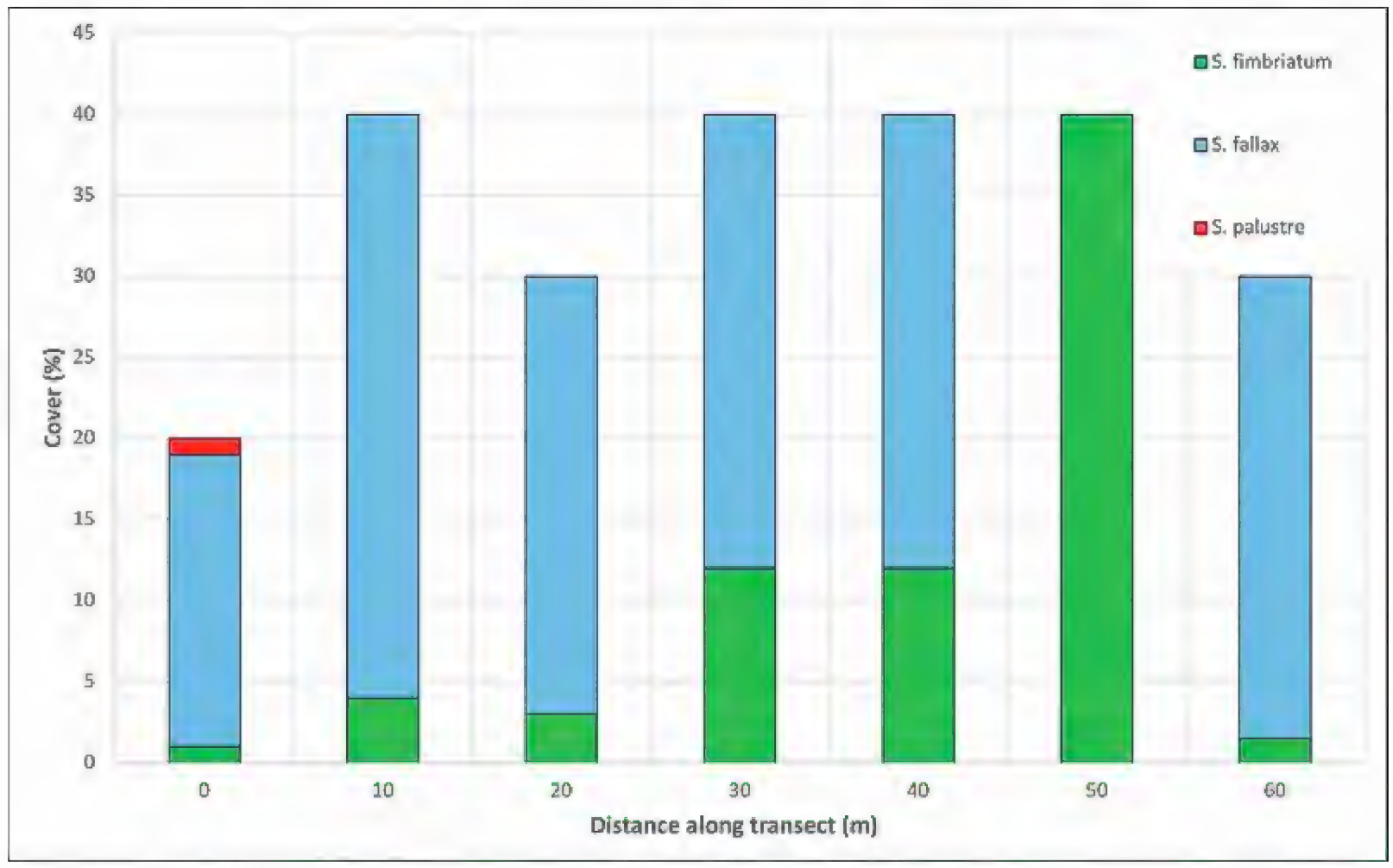

Figure 6. The *Sphagnum* cover and species at White Path Moss; northerly horizontal transect (west to east).

Most likely due to the topography, White Path Moss has the first three niches present (Table 3, p7) but not flushes or carpets. There is still a high proportion of *S. fallax* with it being in all but one of the quadrats. Other mosses that were identified include Red Bog-moss *S. capillifolium* subsp. *rubellum* and the hummock peat-building Papillose Bog-moss *S. papillosum*. Dense areas of Heather lined the boundary of the bog with sedges such as Common Cottongrass within the mire. There was also a high concentration of Cranberry *Vaccinium oxycoccos*, a healthy bog indicator species, within the *Sphagnum*. Pollutant levels and pH were in between the two other sites, perhaps reflecting White Path Moss's status in terms of recovery.

Migneint had the greatest *Sphagnum* cover of all three sites with >90% cover (Figure 7) and all ecological niches represented (Table 3). The remaining 10% was composed of healthy upland blanket mire indicator species (Table 4, p7), which means a high-water table can be inferred. There was a low dominance of *S. fallax* and a high presence of *S. capillifolium* and *S. papillosum* (Figure 7, p12). Heather and other dwarf shrubs were present in low numbers. Pollutant levels were the lowest of all three sites; this is attributed to the site's remoteness from any industrial centres and its Atlantic coast situation with wet, westerly prevailing winds.

General views of each site are shown (Figures 8Ai, 8Bi & 8Ci, p13). Photographic evidence illustrates that areas of Black Hill outside the managed areas are dominated by grassland and eroded peat haggs (Figure 8Aii). This clearly shows the potential importance of controlled intervention in promoting the recovery of severely degraded upland peat mires. The photographs taken at White Path Moss indicate there are small areas of recovering bog that are at the end point of a recovery trajectory for restoration (Figure 8Bii). Although relatively small in extent and not yet widespread, they signify that an unmanaged site does have the potential to recover and eventually become closer to a healthy, actively growing, blanket bog, as illustrated by Migneint (Figure 8Cii). In addition, plants such as Bog Asphodel *Narthecium ossifragum* and Sundew *Drosera rotundifolia,* indicative of healthy upland mire, were present. Bog Rosemary *Andromeda polifolia,* believed extinct in the area since the 1970s, was rediscovered.

Table 5. Chemical water quality indicators taken at White Path Moss and Black Hill with the values for Migneint taken from Caporn *et al*. (2006).

Pollutant	**Black Hill (2019)**	**Ringinglow Bog (2019)**	**Migneint (2006)**
pH	3.02	3.24	4.46
Sulphate (mg/l)	3.5	2.25	1.385
Nitrate (mg/l)	0.595	0.183	0.083
Ammonia (mg/l)	0.834	0.091	0.014
Phosphate (mg/l)	0.834	0.836	0.062

For the pollutants tested, Black Hill had the highest pollutant concentrations for sulphate and nitrate. It also had the lowest pH, a consequence of its past degradation by sulphur pollution. Migneint Bog had the lowest concentrations and the highest pH, showing its health compared to the other sites. White Path Moss fell in the middle of these two sites.

Discussion

The results indicate that *Sphagnum* at Migneint Bog was extensive and diverse, supporting previous observations (Caporn *et al*., 2006). A notable difference from the two other sites was the lower abundance of *S. fallax* and *fimbriatum* and the dominance of the hummock species including *S. capillifolium, S. papillosum* and Magellanic Bog-moss *S. magellanicum* as shown in figure 7, p12. One of the key distinctions in the recovery of heavily degraded sites has been the appearance of *S. fallax* and *S. fimbriatum* monoculture that re-establish as the bog conditions improve. In healthy sites, we expect this dominance to be reduced by the appearance of mixed species in large hummocks and the other niches such as carpets and flushes. One of Migneint's key distinctive indications of its good ecological condition is the large flushes of *S. magellanicum* that were present. Listed as a species of interest in the Migneint-Arenig Dduallt SAC management plan; it is a locally uncommon indicator of healthy blanket bog (Evans *et al*., *loc. cit,*).

It is clear that there is a greater *Sphagnum* diversity at White Path Moss compared to Black Hill and more of the typical plants of an upland mire ecosystem, for example Bog Asphodel and Bog-rosemary. This raises the question of why is this so. White Path Moss has had no restoration work or *Sphagnum* reintroduction but is healthier in terms of both its cover and diversity when compared to Black Hill. Identifying the factors that influence these differences in recovery may be informative in helping define the extent of restoration work required on degraded sites.

A range of factors could be influential; for example, the topography of an area will affect the water table and water storage in the mire system. This will influence the species supported. White Path Moss lies in a shallow depression with Stanage Edge to the north. The bog only has one drainage point where East Brook cuts through the bog and runs into Burbage Brook. This leads to a much wetter site with a high water table maintained throughout the year. Such conditions are important for healthy *Sphagnum* communities (Carroll, *et al.,* 2009). In comparison to this, the Black Hill *Sphagnum* areas are situated on top of a plateau. As Allott *et al*. (2009) state, it is a common misconception that such a flat location would promote water retention. In fact the opposite is the case here as steep side-slopes can result in water draining quickly, especially if erosional gullies have formed. This leads to a much drier ecosystem which is unsuitable for *Sphagnum* or other upland mire mosses. A problem with sites where the associated vegetation has been lost is that the exposed peat then dries and becomes susceptible to erosion. Over time this results in colonisation by dwarf shrubs, further changing the ecosystem dynamics of the site. Trying to retain water within such degraded sites when moss cover has been lost can be a difficult and lengthy process. This is one of the explanations for the lower diversity seen at Black Hill.

Past pollution may be still affecting sites. The main cause of the initial *Sphagnum* decline was particulate air pollution deposited on the peat, which can stay in the system and still be affecting cover and diversity twenty years after initial deposition (Mylona, *loc. cit,*). This can be seen within the peat layers at sites around Sheffield; core samples taken from White Path Moss in 1999 showed increased levels of heavy metals such as lead, aluminium and iron from steel production in the city east of the site. Increased presence of associated heavy metals will displace lighter non-transitional metals such as sodium, magnesium and calcium that are more beneficial to ecosystem functioning. These are already in relatively lower abundance due to

the area being inland and away from maritime influences and being geologically dominated by gritstone (Gao *et al.*, 1999). In the last few decades, sulphur emissions have dropped due to a decline in manufacturing and increased awareness of the damaging consequences of sulphur pollution on ecosystems (Tallis, 1964). In this context *Sphagnum* recovery in the Peak and South Pennines has been challenging; the legacy of pollution and land-use change has led to an altered hydrology and the consequential spread of heathland across the region.

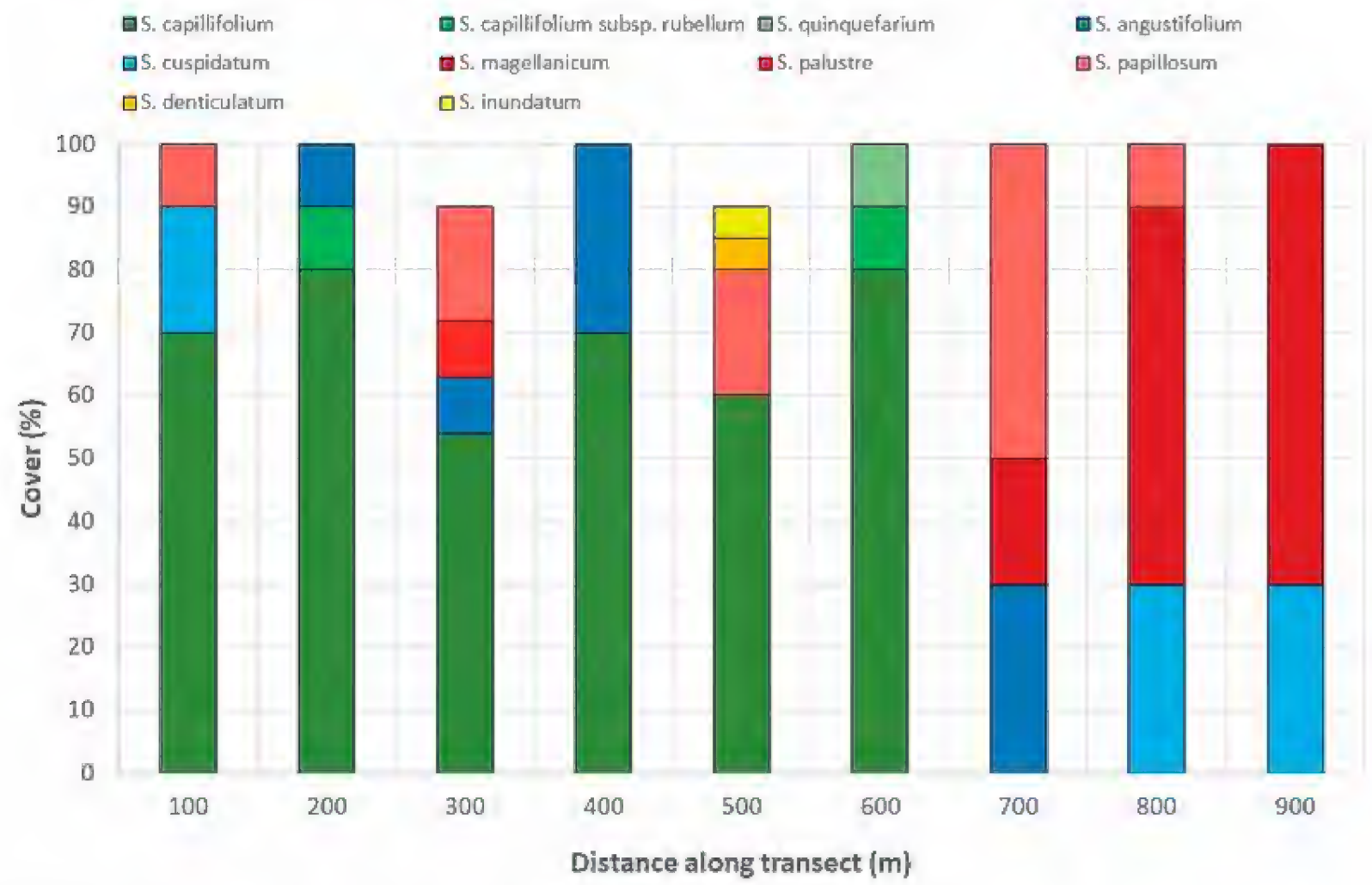

Figure 7. The *Sphagnum* cover and species at Migneint.

Another factor influencing differences in diversity could be the interactions between the *Sphagnum* and other plants. Current research has shown that *Sphagnum* growth can be enhanced by a low density of vascular plants which help provide shelter and generate more stable temperatures and humidity, but at the same time allow space for mosses (Benson *et al.*, 2021). This especially favours hummock growth (Pouliot *et al.*, 2011). At White Path Moss, for example, dense dwarf shrubs such as Heather line the edges of the mire with sedges and grasses such as Common Cottongrass and Yorkshire Fog *Holcus lanatus* abundant in the main bog area. This vegetation structure was also noted by Goulder (2015), who commented on the abundance of Common Cottongrass within the main area of the bog. Being less dense in its vegetation compared to Heather, this grass-dominated vegetation creates shelter and temperature stability and has more space available to allow the *Sphagnum* to grow without being outcompeted. Common Cottongrass also favours similar conditions to *Sphagnum* and both decompose to form peat. Due to the drier nature of Black Hill, many areas are covered in Heather, Bilberry and Crowberry *Empetrum nigrum*. This dominance means that *Sphagnum* will be outcompeted in many areas and indeed is one of the reasons why most of the *Sphagnum* has been introduced in hollows where the cover of these forbs is lower and there is increased

water availability.

Black Hill *Ai*

Aii

White Path Moss Bi

Bii

Migneint Bog Ci

Cii

Figure 8. Photographs showing similarities and differences in health between sites.

Vegetation trajectories produced by MFFP indicate that, as the cover of *Sphagnum* and Common Cottongrass increases over time, dwarf shrub cover should start to decrease (Alderson *et al.,* 2019). One of the key distinctions between a site beginning its recovery and when it is starting to move towards healthy active blanket bog is the increase in the numbers of *Sphagnum* species and a move towards large hummock growth. Current *Sphagnum* modelling trajectories estimate that a good level of cover can be achieved within four years but it could take more than twelve to see a notable diversification in *Sphagnum* (Alderson *et al.*, *loc. cit*). It is important to develop knowledge that underpins these timescales, which are currently poorly under-

stood. White Path Moss is at this stage of diversification. Although there is still a high presence of *S. fallax* within the bog there is also increasing cover of *S. capillifolium* subsp *rubellum* and the hummock-forming *S. papillosum* and *S. palustre*. One of the uncertainties with the vegetation recovery trajectories on previously degraded sites is whether the *Sphagnum* will follow its usual succession in species dominance and diversity. *S. fallax* and *S. fimbriatum* should gradually be outcompeted by the larger hummock species over time. This is indicated in some of the quadrats at White Path Moss where a transition is seen from a dominance of *S. fallax* to that of *S. papillosum* and *S. palustre* (Figures 4 and 5, p8-9).

At Black Hill there is currently a high dominance of *S. fallax*. This is expected as this was the only species available in propagule form when *Sphagnum* reintroduction was first started on the site. With transition from beads to plugs the numbers of species available increased up to eleven *Sphagna* contained in one plug which should encourage a higher diversity on site. However, these plug plants take longer to establish and need to be individually planted in sheltered areas to give them the best chance of establishing. Due to this, there will be a greater time lag between planting and the development of a higher diversity of *Sphagnum* mosses. The timescale for this is as yet unknown.

The presence and health of *Sphagnum* plays a crucial role in the way the entire ecosystem functions. When examining the relationship between cover and species diversity, as the *Sphagnum* grows and joins together to form carpets and hummocks, it should become less vulnerable to desiccation. This is because *Sphagnum* can effectively lock the water table around it to the surface (Robroek, *et al.*, 2009). This encourages other upland blanket mire indicator species to return as conditions become less suitable for dwarf shrubs. Comparing White Path Moss to Black Hill there was a higher diversity of other wet moorland and mire indicators at White Path Moss including Sundew, Bog Asphodel, Bog Rosemary, Crowberry and Tormentil *Potentilla erecta*. The areas of Sundew were all concentrated in zones rich in *S. papillosum*.

While Black Hill did have a high cover of Crowberry and Bilberry with a drier landscape compared to White Path Moss, most vegetation around the *Sphagnum* was dwarf shrub. There was also a presence of grasses, mainly Common Bent *Agrostis capillaris* and Wavy Hair-grass *Deschampsia flexuosa*. This is most likely due to the initial grass mix that was introduced after the peat was first stabilised. MFFP trajectories estimate that over time this dominance should slowly decrease as the area of mosses increases and the conditions become less favourable for drier grasses and shrubs (Pilkington *et al.*, *loc. cit*).

A final point to note relates to *Sphagnum* propagule introduction from donor sites away from the receiver locations, which is inevitable here because of the lack of suitable regional donor mires. However, this has raised concerns among bryophyte recorders and ecologists about this process of introduction masking natural distributions and recovery and the potential for the introductions of pests and diseases. In the South Pennines, whilst historical records were gathered this was not comprehensive and there was no detailed site survey across the region prior to introduction (Tom Blockeel pers. comm.; Paul Ardron pers. comm.). This was perhaps in part because it was felt that there was little *Sphagnum* presence or diversity to be found locally. White Path Moss and on-going surveys across the Peak District confirm that there is indeed a significant natural resource already colonising but not in the extreme conditions of Black Hill and the other MFFP sites.

In conclusion, this paper considers how *Sphagnum* recovery has varied between managed and unmanaged degraded sites using case study locations within the Peak and South Pennines. Both White Path Moss and Black Hill have been modified and degraded from past land use and pollution with a resulting loss of *Sphagnum*. A higher *Sphagnum* cover and species diversity is now seen at White Path Moss, but the site has been recovering for longer (since the 1940s) and was never as heavily impacted by pollution compared to areas like Black Hill that lie in the prevailing wind direction. Due to this, some areas of White Path Moss have transitioned from *S. fallax* to areas of hummock species. Migneint Bog is a very diverse site with a higher percentage of *Sphagnum* cover that is dominated by hummock growth; it represents what recovering sites are aiming to become. White Path Moss is moving towards this destination. It is still in its recovering phase, but the return of its blanket mire indicator species is a good sign for its recovery.

These observations suggest that not all sites require intervention for *Sphagnum* recovery to occur. Presenting the variations in the cover of each species at each location allows a greater understanding of the trajectory of a bog's recovery. However, severely degraded sites such as Black Hill have not recovered naturally in the timescales observed. This indicates the need for intervention in problematic sites. Once bare peat with a complete loss of *Sphagnum*, the plateau now has large carpets of *S. fallax* and thus a beginning in any future recovery towards a more diverse *Sphagnum* cover and bog functionality. Recognising the range of factors that cause this transition from a *S. fallax* dominated site to one with hummock building *Sphagnum*, and increased vegetation typical of upland mire, is important in guiding future recovery and restoration.

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The *Sphagnum* mire at Cromwell Bottom Nature Reserve

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Introduction

The presence of a small area of *Sphagnum* mire at Cromwell Bottom Nature Reserve in the Calder Valley is a significant ecological feature, possibly unique in the country. The colonisation of mire species of acid soils onto a strongly calcareous pulverised fuel ash (PFA; sometimes called 'fly ash') substrate is an unusual, but known process. Here we present a little of the story of the Nature Reserve, the mire and its current vegetation.

Cromwell Bottom Nature Reserve

Cromwell Bottom NR (designated as both a Local Wildlife Site and Local Nature Reserve) is owned and managed by Calderdale MBC with assistance from the Cromwell Bottom Wildlife Group. It is located within the Calder Valley south-west of Brighouse, sandwiched between the River Calder and the Calder & Hebble Navigation, both of which run west to east. The location of the reserve and some of the features referred to in the article are shown in Figure 1.

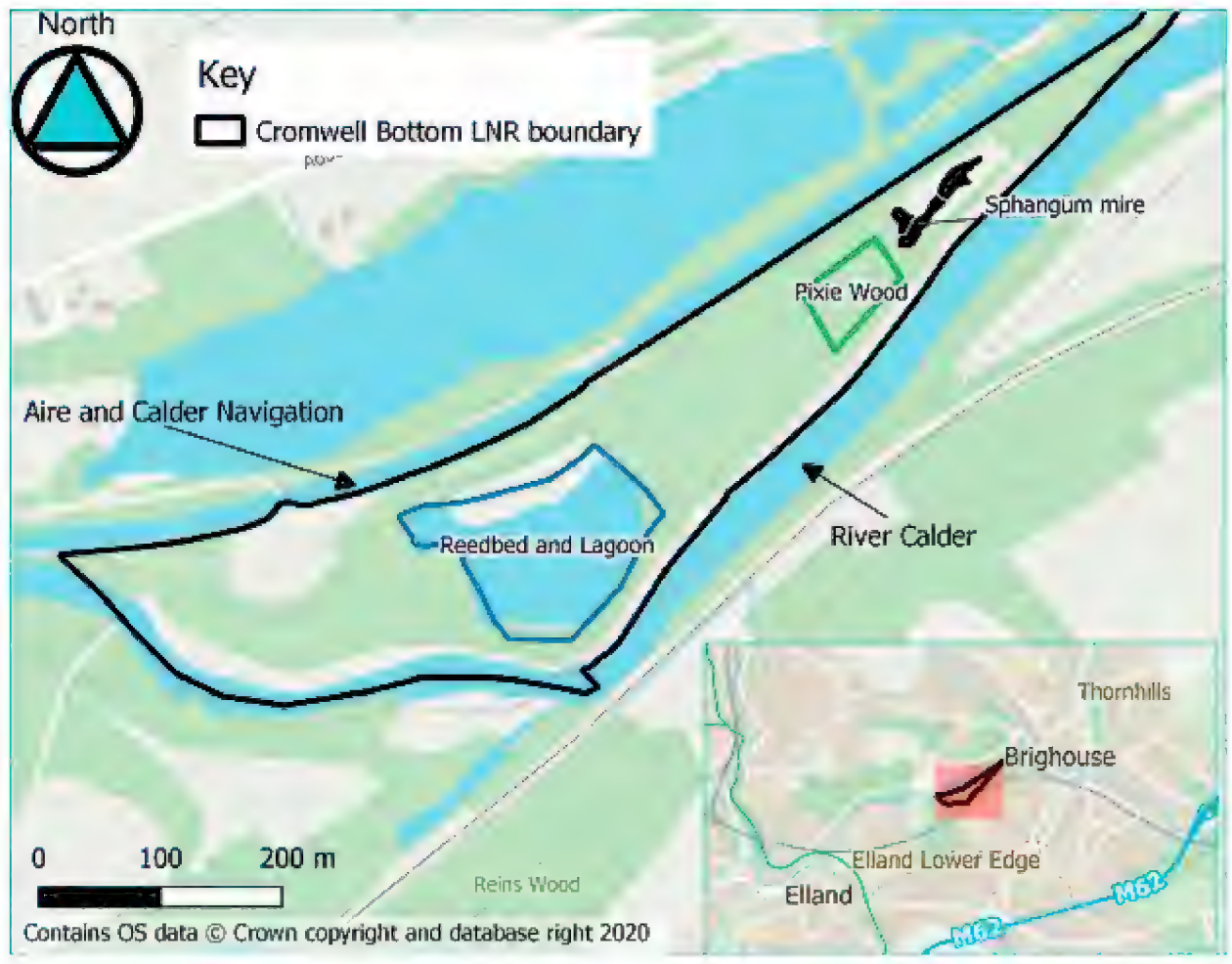

Figure 1. Map showing location of Cromwell Bottom Nature Reserve.

The history is summarised in Richard Wilson Ecology (2017) as "Cromwell Bottom NR extends for approximately 30 ha on land that has been subject to complex disturbances over the last six decades. During the 1950s and 1960s, the glacial gravels were extracted for the building industry and then subsequently infilled with coal washery tailings, PFA, or used as sludge lagoons during the operational period of the coal-fired Elland Power Station (1960s to late 1980s/ early 1990s). Subsequently, the PFA was partially extracted to provide material for the construction

of the M62 before some of the gravel pits were infilled with landfill and subsequently capped; or filled with water and managed for angling. However, the sludge lagoon, which is roughly central to Cromwell Bottom NR, was left in situ though landscaped with its mix of PFA, gravels and other materials and subsequently developed a mosaic of vegetation communities that were recognised as supporting regionally important flora and fauna, which is partly considered to be a consequence of its past use."

At Cromwell Bottom the re-excavation of PFA left a series of lagoons bunded by relatively impermeable banks around the perimeter. The site has a relatively small catchment, with currently all water input coming from rain water, but leaving the site prone to drying for prolonged periods in the summer. The site has been managed by Calderdale MBC and the Wildlife Group since 2000, and the reedbed is maintained by regular cutting, and the wet and birch woodland areas are also managed for wildlife interest. The north-eastern most basin is particularly isolated from the other wetlands, and it is here that the Sphagnum mire has developed.

Sphagnum mires and _Sphagnum_ colonising mineral sites

Mosses in the genus *Sphagnum*, with 38 species known from the UK, are 'ecosystem engineers' that are fundamental to the development of a range of mire vegetation types. They are perhaps most famous for forming raised and blanket bogs. *Sphagnum* is also a keystone genus in a range of other bog, fen and wet heath vegetation types. Formation of deeper peats requires long-undisturbed mire surfaces, but *Sphagnum* is also an excellent coloniser where suitable conditions exist. In the past it has appeared at many mineral extraction sites, typically at damp margins of waterbodies, a phenomenon which has become less common as the prevalence of acid rain has decreased.

Calcareous PFA and acidophilous mire vegetation

The ecology of PFA is discussed in detail in Shaw (1994). The PFA behaves a lot like sand, and when fresh has a pH between 9 and 11. It has high (phytotoxic) concentrations of boron, similar to sea water, meaning the vegetation that initially develops on PFA is halophytic. However, the harsh conditions reduce over time and, on many sites, vegetation normally develops via calcareous grassland into woodland in around 30 years. One unusual property of PFA that encourages the development of mires is that it can react with free lime (often present in the PFA mix) to form a stable cement, which often happens creating an impermeable pan around 10-20cm below the surface.

Shaw (1994) presents details of *Sphagnum* colonising PFA, which typically happens at damp sites within the closed woodland as the leaf mould builds up a base of acidic material, and the soils rarely support earthworms so that there is little mixing of the layers. This creates the humus layer and a mor soil profile on which the acidophilic bryophytes are able to colonise. At Cromwell Bottom, this seems to be the process likely to explain the formation of the *Sphagnum* mire except that, rather than taking place under a closed canopy, the litter has formed from adjacent trees, with the *Sphagnum* bog forming in open conditions. This is the situation which appears to be unique, a result of the topography and vegetation development sequence at Cromwell Bottom, with aerial images showing the presence of a raised area of dry birch wood known as Pixie Wood adjacent to the south-west edge of the mire area in 2000 as the most likely source of organic matter.

The *Sphagnum* mire has developed in the eastern-most basin, separated from the main reedbed and wet woodland by Pixie Wood. It occupies an area of around 1800m^2, and comprises two distinct areas, referred to as the *Sphagnum* mire to the east and reed fen to the west.

Vegetation

A survey of the site in May 2021 by one of the authors (SH) was used to collect quadrat data from the two distinct areas and compare these to published NVC communities (Rodwell, 1991a, 1991b, 1995). Full details are contained in an unpublished technical note (JBA Consulting 2021) including a discussion of condition available on request from the authors. The vegetation analysis is summarised below.

The floristic data show that the *Sphagnum* mire is a best fit with **M6c *Carex echinata-Sphagnum recurvum/auriculatum* mire, *Juncus effusus* sub-community**. This community is typical of mires on acidic substrates but where there is some enrichment from nutrient. It often occurs on relatively shallow peats. At Cromwell Bottom it is typically composed of a dense carpet of the mosses *Sphagnum palustre, S. fallax* and *S. fimbriatum, Polytrichum commune* and *Aulacomnium palustre*. Scattered through these, constant but never abundant, are Soft-rush *Juncus effusus*, Common Cottongrass *Eriophorum angustifolium* and Hare's-tail Cottongrass *E. vaginatum*. The community constant for the published community, Star Sedge *Carex echinata,* is absent from Cromwell Bottom. Seedlings and saplings of Downy Birch *Betula pubescens* are also constant, but are periodically cut back or removed as part of the site management. This vegetation supports a small colony of wonderfully red *S. medium* (previously *S. magellanicum*), a notable species of bog-moss more typically found on deeper peats in undisturbed mire systems (Figure 2, p20). This is the only known natural site for this species in VC63, the other known site, Thorne Moors, having had the species introduced (McDonald, 2014).

The reed fen is much more difficult to classify. It comprises a tall layer (>2m high) of Common Reed *Phragmites australis* with thinly similarly tall Grey Willow *Salix cinerea* and Downy Birch scrub, with scattered stems of the non-native Himalayan Balsam *Impatiens glandulifera*. There is a thinly spread lower layer of vascular plants including most commonly Square-stalked Willowherb *Epilobium tetragonum*, and Soft-rush. There is then a ground layer, somewhat patchy, of mosses including *Sphagnum fallax, S. squarrosum* and *S. palustre* with *Aulacomnium palustre* and *Calliergon cordifolium*. Invading birch scrub drives the vegetation towards the NVC community **W2 *Salix cinerea-Betula pubescens-Phragmites australis* woodland**, and possibly **W4 *Betula pubescens-Molinia caerulea* woodland**. The vegetation is not wet enough to represent **S4 *Phragmites australis* swamp and reed-beds**, and the cover of Common Reed is too high (and there are no sedges) so the vegetation is a poor fit to **M5 *Carex rostrata-Sphagnum squarrosum* mire**, despite the abundance of *Sphagnum squarrosum*.

Scrub invasion, management and the future

The most apparent threat to the persistence of the mire is the invasion of scrub. The mire is small for such habitats in the lowland, and as such is particularly vulnerable to drying, which is exacerbated by scrub invasion. Current management involves the removal of the invading scrub, carried out by volunteers led by Calderdale Council as part of the general reserve maintenance (Figure 3, p20). The long-term persistence of the mire would appear to depend on the combination of this scrub control, along with the influx of sufficient water to maintain the *Sphagnum* growth. The latter is by no means guaranteed in a changing climate. It is hoped

this article and the JBA report (JBA Consulting, 2021) provide a useful baseline against which to compare future monitoring of the site.

Left: Figure 2. *Sphagnum medium* growing at Cromwell Bottom.
Right. Figure 3. Scrub control being carried out on the reserve (see p19).

Photos: Steven Heathcote

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Changes in *Sphagnum* communities on Ilkley Moor between 1972 and 2021

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Introduction

Dalby (1972) surveyed 22 peat bog sites for bryophytes and pH levels on the northern slope of Ilkley Moor. Suggestions were raised that the changing face of the Moor was a concern as, with many peat bog habitats, Ilkley Moor was and still is at risk of drying out and homogenisation with the encroachment of Crowberry *Empetrum nigrum* into the bog areas (Hale & Cotton, 1993; Swindles *et al.,* 2019). An ability to quantify the changes in vegetation of these essential yet declining habitats may allow for appropriate management strategies to be put in place before permanent damage occurs to the moorland ecosystem.

Methods

This project has repeated these studies, closely following the methods set out in Dalby (*loc. cit*) giving a 49-year picture of the changes in these bryophyte communities.

Grid references were taken from Dalby (*loc. cit*) along with site descriptions. These were used to identify the sites which were then recorded using what3words™ for sample collection (Table 1). This will hopefully allow for easier repetition of the study in future years (see Table 1). All data collection was completed on 8 May 2021 to allow for consistent climatic conditions. Weather conditions on the day are described as cloudy and temperature varied between 8 – 10°C. Water samples were taken at each site where possible and a pH test conducted. *Sphagnum* communities were identified using the JNCC *Sphagnum* field identification guide (Hill, 1992). Sites were visited in order from the west of the Moor, working down Keighley Road, and across the Moor, working toward the east (see: Figure 1).

Figure 1. Map of survey locations in Ilkley Moor

Table 1. Sample site names and locations across Ilkley Moor.

1974 Bog No.	1974 Bog Name	what3words location	1972 Grid Reference
1	Weary Hill Flush	nature.neatly.asteroid	SE 107463
2	Quarry Bog	apples.certified.blackmail	SE 108463
3	Silver well flush	downs.rainy.wakes	SE 108468
4	Trichocolea flush	brave.punks.worthy	SE 113468
5	Hawthorn Flush	mailing.steaming.shallower	SE 109465
6	Spicey Flush	thickens.frame.chuck	SE 109466
7	Barmishaw Flush	outfitter.rang.albums	SE 114463
8	Unnamed	cabbages.blatently.lightly	SE 114464
9	Unnamed	hiking.commuting.fictional	SE 116467
10	Unnamed	swatted.joked.snack	SE 114469
11	Whitewells Bog	expiring.toasted.placed	SE 117468
12	Unnamed	shred.divide.mime	SE 118468
13	Unnamed	salutes.frown.presumes	SE 119469
14	Unnamed	trips.ultra.margin	SE 124469
15	Unnamed	redefined.extent.thirsty	SE 124468
16	Bog E of upper tarn	senders.riot.starlight	SE 121468
17	Unnamed	overruns.kite.nylon	SE 119465
18	Cranshaw Bog	melons.handicaps.tingled	SE 122463
19	Lanshaw Bog	affair.easy.airstrip	SE 134453
20	Sundew Flush	voter.roses.rant	SE 143450
21	Unnamed	drip.eliminate.flopped	SE 150451
22	Carr Bottom Flush	nylon.harsh.protect	SE 147444

Results

Sphagnum counts

Overall *Sphagnum* species have declined across the Moor between the two survey years, Site 13 being the only site with an increased species diversity (see Figure 2). At Sites 12, 14 and 15 the bog area has disappeared almost completely, generally being taken over by grasses and Bracken, with little evidence of bog plants at these locations.

Comparison of individual sites

In Dalby (*loc. cit*) only 13 of the 22 sites are discussed in detail, this section compares these 13 descriptions with current conditions:

1. Weary Hill Flush (GR SE108463, altitude: 975ft). The 1972 report states that the springs feeding the bog range from 4.9 to 7.1 (ave: 6.0) pH. By 2021 this had changed to a range from 5.9 to 6.1pH (ave: 6.0). While the average pH has not changed the range has narrowed.

The 1972 recording lists eight types of *Sphagnum* (s.) (*S. palustre, S. papillosum, S. teres, S. recurvum, S. cuspidatum, S. contortum, S. robustum and S.plumulosum*). The 2021 survey suggests there are only three species remaining (*S. papillosum, S. recurvum and S. fimbriatum*). It is of note that *S. fimbriatum* has appeared at this location since the earlier study.

2. Quarry Bog (GR SE108463, alt. 950ft), described as a bog area on the quarry floor. The pH

here has increased from 5.7 to 5.9 on average. *Sphagna* from 1972 included *S. recurvum, S. cuspidatum, S. subsecundum, S. plumulosum, S. palustre* and *S. capillaceum* . This study suggests species present are reduced to *S. recurvum, S. squarrosum* and *S. cuspidatum.* It is of note that *S. squarrosum* has appeared at this site since the 1972 study.

3. Silver Well Flush (GR SE108468, alt. 750ft). This area has seen the largest increase in pH, rising from 3.7 in 1972 to 6.1 in 2021. In 1972 this site had a sole community of *S. recurvum.* The dominance of *S. recurvum* at this site was still evident in 2021, being the sole *Sphagnum* species found at the site.

4. Trichocolea Flush (GR SE113468, alt. 750ft). This is one of few areas that have seen a decrease in pH level, from 6.4 to 5.2. At this location the diversity of *Sphagna* has decreased from seven species to two, with *S. palustre*, *S. teres*, *S. recurvum*, *S. subsecundum* and *S. plumulosum* not being identified at this site in 2021. Only *S. squarrosum* and *S. fimbriatum* were identified in the 2021 survey.

5. Hawthorn Flush (GR SE109465, alt. 750ft). This site has seen an increase in pH from 5.1 to 5.5. It is interesting to note that the average pH in 1972 was comprised of two readings; 4 & 6.2, whereas in 2021 the pH was comprised of three readings, 5.8, 5.7 and 5.1. While the average increase is only 0.4 it would appear that the extremities of this bog have become less severe. In 1972, *S. palustre*, *S. teres*, *S. squarriosum* and *S. recurvum* were all present. This study suggests that this site had become a monoculture of *S. recurvum*.

6. Spicey Flush (GR SE114463). This site is one of few that have seen a decrease in pH from 7 to 5.6, leading to a more acidic environment. This may be as a result of some slowing of drainage in the area (Wilson *et al.,* 2011). In 1972, *S. recurvum* and *S. squarrosum* were identified whereas in 2021 only *S. recurvum* appeared to remain.

7. Barmishaw Flush (GR SE114463). Again, this bog has decreased in pH from an average of 5 in 1972 to an average of 4.7 in 2021. As with most bogs in this report though, the extremities would appear to have smoothed out (most acidic reading in 1972 was 3.1 and 4.0 in 2021). The 1972 survey found evidence of *S. teres*, *S. squarrosum, S. recurvium, S. subsecundum, S. fimbriartum* and *S. plumulosum*. This appears to have now decreased to *S. teres* and *S. recurvium.*

11. White Wells Bog (GR SE117468, Alt. 600ft). pH has decreased at this location, leading to a more acidic environment. This may be due to one high reading in 1972 contributing to a high average for that year. This location has seen some of the biggest losses in *Sphagnum* communities, decreasing from *S. papilosum, S. teres, S. squarrosum, S. recurvum, S. cuspidatum, S. subsecundrum, S. fimbriatum* and *S. plumulosum* in 1972 to only *S. fimbriatum* identified in 2021.

16. Bog E. of Upper Tarn (GR SE121463, alt.725ft). This bog has increased in pH from 5 to 5.4 over the 49 years. Similar to the other bogs in the area, there has been a decline in species from *S. papilosum, S. teres, S. squarossum, S. recurvum* and *S. plumulosum* in 1972 to only *S. recurvum* identified in 2021.

18. Cranshaw Bog (GR SE122463, alt. 1075ft) has seen a large increase in pH, from 3.1 in 1972 to 5.8 in 2021. This may be due to observed modern drainage works in the area that appear to allow the bog area to drain effectively, leading to less standing water and, potentially, the

higher pH level. In 1972 the bog supported *S. recurvum, S. cuspidatum* and *S. girgensohnii,* however only *S. recurvium* was identified in 2021.

19. Lanshaw Bog (GR SE134453, alt. 1150ft) has seen an increase in pH from 5.3 to 6.1. Again, while this average increase does not appear large, the extremities appear to have narrowed, ranging from 3.1 – 7.0 in 1972 and 5.6 to 6.1 in 2021. The 1972 survey found *S. palustre, S. papilosum, S. recurvium, S. tenellium, S. fimbriatum* and *S. plumulosum* whereas the 2021 survey only recorded *S. recurvium* and *S. cuspidatum*.

20. Sundew Flush (GR SE143450) - this area has a decreased pH from 5.2 to 3.8, this may be due to the abandonment or non-management of drainage systems around the location leading to a more acidic environment in the bog. The 1972 survey found *S. palustre, S. papilosum, S. recurvum, S. cuspidatum, S. subsecundum, S. finbartum, S. capillaceum* and *S. plumulosum* whereas the 2021 survey only identified *S. recurvum* and *S. cuspidatum.*

22. Carrbottom Flush (GR SE147444) also decreased in pH level, from 6.9 in 1972 to 4.4 in 2021. Again, this may be due to the decrease in effective drainage in the area. The *Sphagna* in the area have declined from *S. papilosum, S. magellanicum, S. teres, S. squarrosum, S. recurvum, S. finbartum and S. plumulosum* to *S. teres, S. squarrosum, S. recurvium* and *S. plumulosum* in 2021. It is interesting to note that *S. magellanicum* was only identified at this site in 1972 and not discovered at any site in the 2021 survey, potentially suggesting that this species may have been lost from the Moor.

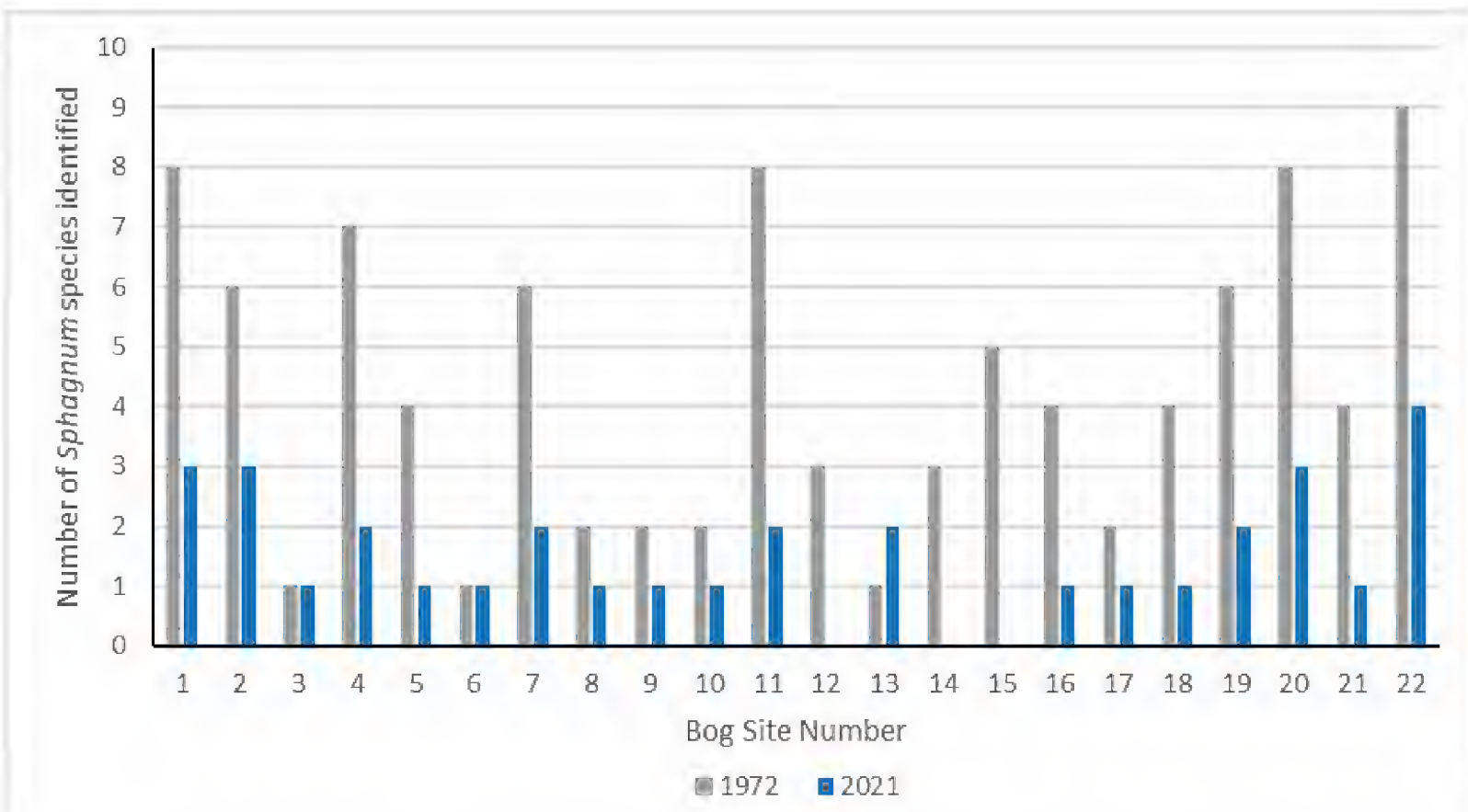

Figure 2. Comparison of *Sphagnum* species identified in Dalby (1972) and 2021 survey.

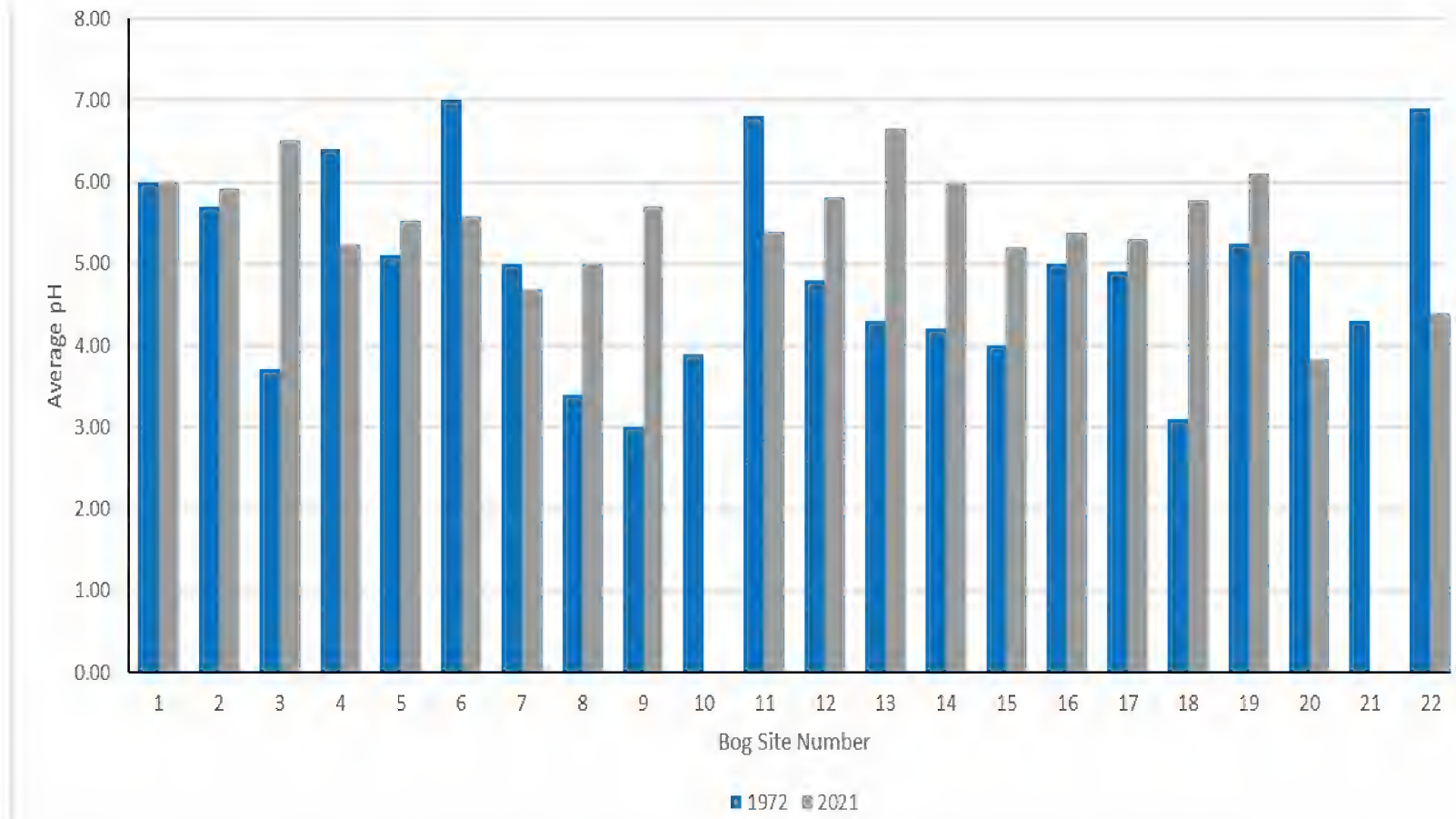

Figure 3. Comparison of average water pH levels of bog sites from Dalby (1972) and the 2021 survey.

Water pH level

On average, the pH has increased by 0.59. However, Figure 3 shows that this is not a consistent increase across all sites, six of the 22 areas have decreased in pH. At bogs 12, 14 and 15 there were small pools or streams where water samples could be taken but these were surrounded by grass and no typical bog plant communities. Sites 10 and 21 were unable to be sampled.

Table 3: Comparison of *Sphagnum* identifications by type 1972 – 2021

***Sphagnum* species**	**1972 presence count**	**2021 presence count**
Blunt leaved bog moss *S. palustre*	16	3
Magellanic bog moss *S. magellanicum*	1	0
Papillose peat moss *S. papillosum*	6	0
Rigid bog moss *S. teres*	7	1
Spikey bog moss *S. squarrosum*	7	7
Recurved sphagnum *S. recurvum*	22	16
Soft bog moss *S. tenellum*	1	0
Feathery bog moss *S. cuspidatum*	5	4
Twisted bog moss *S. contortum*	1	0
Slender cow horn bog moss *S. subsecundum*	7	0
Fringed bog moss *S. fimbriatum*	6	3
Girgensohn's bog moss *S. girgensohnii*	1	0
Russows bog moss *S. robustrum*	1	0
S. capillaceum	3	0
S. plumulosum	11	0

Notes on Sphagnum type

The 2021 survey finds that 14 of the 15 *Sphagnum* species are in decline on the Moor. The exception being *S. squarrosum*, this species has maintained its presence, seven counts in both 1974 and 2021. Six of these seven identifications are in the same bogs between the 1972 and 2021 study, however, at Sundew Flush there may now be a thriving population of *S. squarrosum* developing. Nine species have declined to a point where they are not identified at all in the 2021 study. This can be seen in Table 3, p25.

Discussion and Conclusion

The data presented in this study suggest that all bogs have changed in pH level, with 13 changing by more than 1.0. Six bogs have decreased in pH level, 14 have increased and two are no longer bogs. Anecdotally it is worth noting that some of Dalby's (*loc. cit*) locations were difficult to relocate; where she had described a bog "of a few yards in diameter" now exists a bog less than 1m wide. At this trajectory without further management by 2070 there may be no significant bog habitats on the lower slopes of the Moor. While the overall average changes in bog pH seem small it is important to note that there is a higher change in the extremities of the bogs. Several bogs have become more acidic, which may be partially due to the reverse "improvements" in drainage, such as deliberate attempts to re-wet the moor through not maintaining drainage facilities.

However, where these bogs have become more acidic, potentially due to the longer standing water, there is still no increase in species counts. There is on a few occasions evidence of species appearing in the 2021 survey that were not present at the respective location in the 2021 survey. This may be due to survey errors with either survey, or actual plant migration.

This study could suggest that where rewetting has occurred on the Moor, naturally or through human intervention, it has been successful in creating more acidic conditions. Further investigation would be able to confirm this. Whether more time is required to see if these former *Sphagnum* communities return or they will not naturally return is out of the scope of this paper. Dalby's (*loc. cit*) and this paper give the Moors' managers the opportunity to look at each location, assess the pH current level and re-introduce species that were listed at that point in the 1972 study.

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The great 19th century mange epizootic: Scratching the surface of fox hunting records

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Introduction

The debilitating and often fatal condition of mange in the Red Fox *Vulpes vulpes* is caused by highly infectious infestations of the skin mite *Sarcoptes scabiei,* which burrows into the superficial layers of skin causing a scab of dried tissue-fluid exudate beneath which mites multiply rapidly. Mite debris including shed exoskeletons, digestive secretions and faeces accumulate under the excavated epidermis causing extreme irritation and skin inflammation. Hair is lost in patches and the naked skin assumes a dark, encrusted appearance with the presence of sloughed but unshed epithelial cells. At this stage the characteristic sweet 'mangy' odour, which may be due to secondary bacterial infection, is evident. Though *S. scabiei* is most frequently cited as the causative agent, Lloyd (1980) quotes a case of several Foxes in suburban Cheam, Surrey being severely affected by the skin mite *Notoedres cati*.

The Red Fox in Britain has long demonstrated a susceptibility to mange outbreaks; indeed, the earliest references to diseases amongst foxes in modern literature all refer to what is assumed to be mange (Beckford, 1910). The condition has been familiar to huntsmen since the 18th century when fox hunting became popular, with an outbreak recorded in the New Forest in Hampshire in 1789, during which the Lord Warden of the Forest worried about the 'great scarcity of foxes' (Vesey-Fitzgerald, 1965). Sir Alfred Pease, master of the Cleveland Hounds (Blakeborough & Pease, 1914) claimed "there have always been mangy foxes - certainly for 200 years". Large-scale outbreaks of the disease, though rare, caused major concern in fox hunting circles since Fox populations can be severely reduced, thus limiting the sporting potential of a hunting country. A major epizootic at the turn of the 19th century was alluded to by Gerald Lascelles (1915) which he claims began in 1895 and raged over "almost all of England".

Methods

This study investigates the mange outbreak in the Yorkshire region during the late 19th and into the first decade of the 20th century, when hunt masters and committees were embarrassed by the initially inexplicable scarcity and poor quality of Foxes within their territories. Though occasionally interpreted as a reflection on hunt management and the incompetence of hunt servants, experience in the field demonstrated that the Fox populations were suffering from what developed into a major epizootic of mange. Although specific finds of mange were only occasionally described in hunt diaries, problems with Foxes and the sport they afforded tended to be judged in terms of the number of "blank" days or days lost. Good years were judged by the relatively large numbers of Foxes either killed or run to ground. The following accounts, gathered from evidence in the histories of 8 Yorkshire hunts (arranged in alphabetical order) are supplemented by analyses of hunt kill statistics and find distances. In order to equalise

the variability of hunting effort from year to year and between hunts, kill rates are calculated as representing the number of kills per 100 days' hunting. Find distances are calculated by measuring the distances from the commencement of a hunt to the first find or from a kill site to the next find.

Review of mange evidence in Yorkshire hunt territories

Badsworth: Little evidence has so far been obtained for this hunt but a decline in kills per 100 days' hunting from 83.6 in 1859/60 to 49.4 in 1864 (Dixon, 1899; Simpson, 1927) coincides with a similar dearth of Foxes experienced by the Cleveland hunt (see figure 2) and may reflect a regional mange-related trend for the 1860s.

Bedale: Isolated cases of mange were encountered during the season of 1825/26 at Kilpin (SE2898) and on 22 February 1854 at Hollin Head Wood. Towards the end of the 1895/96 season Foxes became very scarce with "a good many disappointing days" and during the 1903/04 season the mange was described as "epidemic" with Foxes difficult to find in some areas (Reynard, 1908).

Bramham: Diary entries note an isolated though severe case of mange in a Fox found and killed at Cocked Hat Whin on 26 February 1860. Described as "skin and bones" it had no hair and "the hounds refused to eat him" (Simpson, *loc. cit.*). An epizootic of mange broke out in 1894/95. 1895/96 was an "unfortunate season" with Foxes scarce and difficult to find. On 3 January 1896, "Wilstrop Wood and all the coverts in the neighbourhood of the meet were blank". Simpson (*loc. cit.*) noted that although "blank" days were normally experienced only once in every five seasons, two or three blank days were recorded per season when mange was bad with seven recorded during the 1897 and 1898 seasons when Foxes were severely reduced. The outbreak began to abate generally in 1898/99 but broke out again in the west of the Bramham country (Simpson *loc. cit.*).

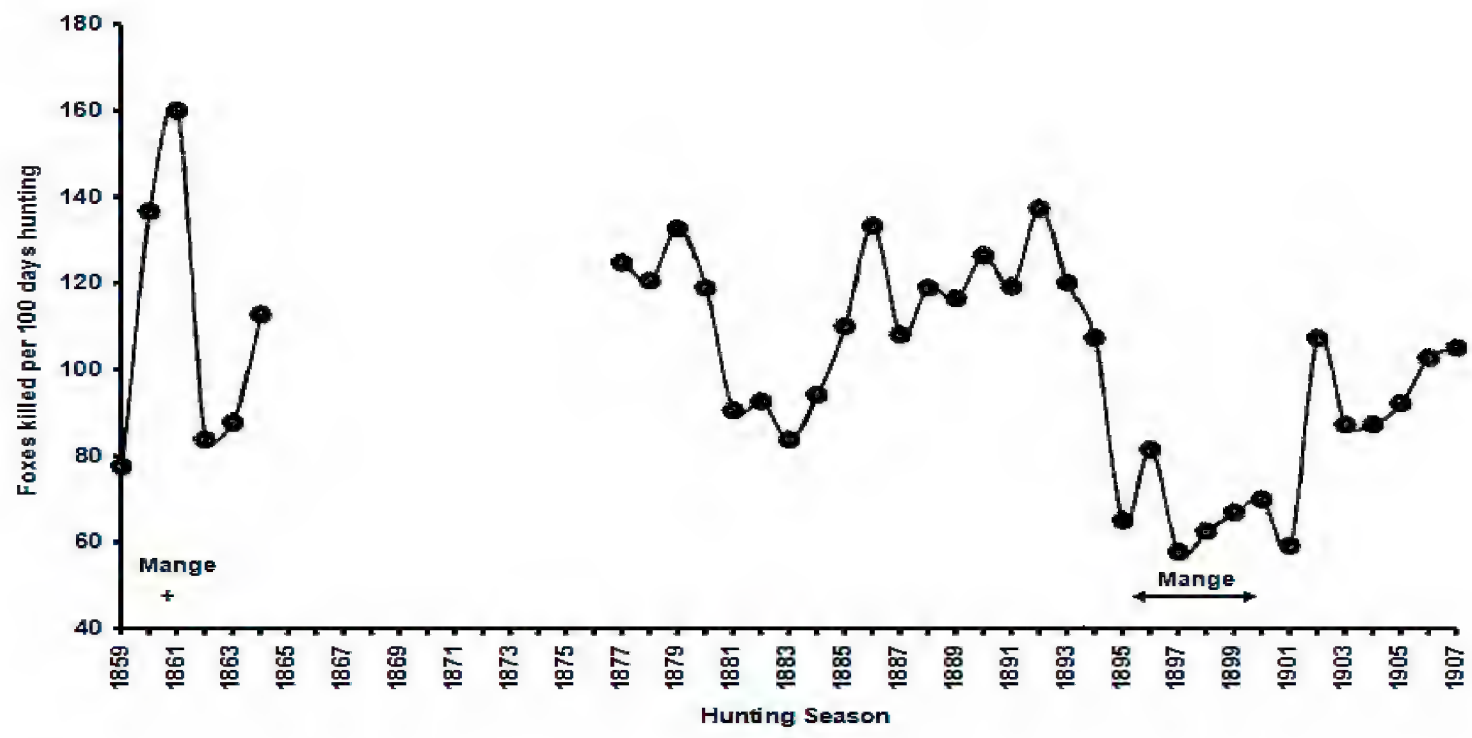

Figure 1. Numbers of Foxes killed per 100 days' hunting by the Bramham Hunt 1859 to 1864 and 1877 to 1907 (Calculated from data in Simpson, 1927).

Figure 1 shows that hunting success rates had been steadily rising from 83.8 kills/100 days in 1883 to a peak of 137.4 in 1892. This was followed by a rapid decline in kills, noticed by

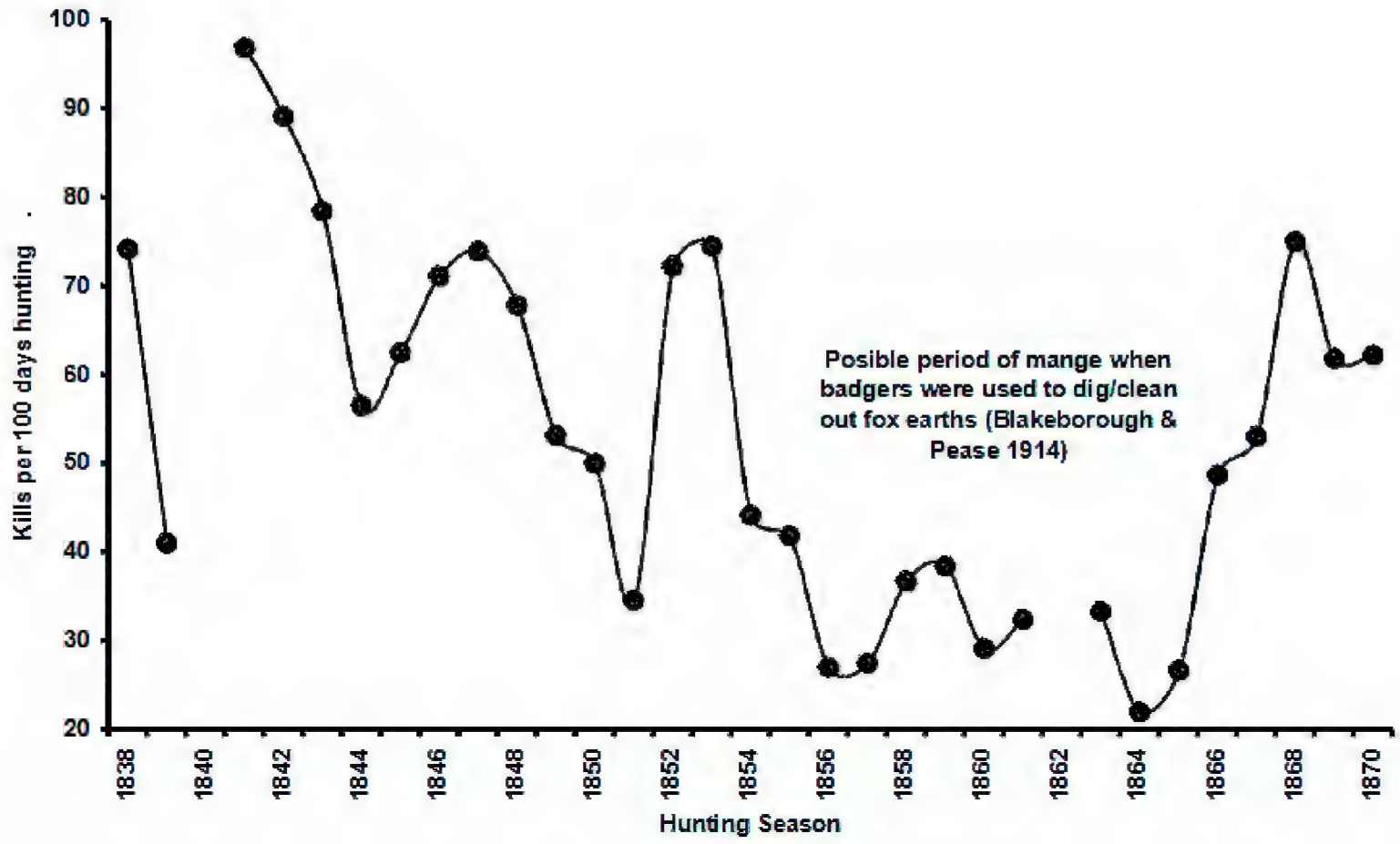

Figure 2. Numbers of Foxes killed per 100 days' hunting by the Cleveland Hunt 1838 to 1870 (Calculated from data in Pease, 1887).

huntsmen in 1895 and falling to a nadir of 57.8 by 1897, the lowest kill rate since 1859. Although huntsmen reported better hunting by 1899, when Foxes were reported to be healthier and were "turning up better" (Simpson, *loc. cit.*), in fact the statistics show that a significant rise only took place in 1902 when the kill rate rose to 107.3 per 100 days' hunting.

The mean annual distances based on data in Dixon (1898) and Simpson (*loc. cit.*) show that this was as low as 0.5km in the peak fox year of 1891 increasing to 2.2km in 1892 as Foxes became scarcer and reaching 4.5km in 1895 when the population was nearing its nadir.

Cleveland: The series of annual Fox kills per 100 days' hunting calculated for the period 1838-1870 (based on data in Pease (1887) (see Figure 2) shows a peak of 74.54 kills/100 days in 1853 followed by a decade-long dearth of Foxes from 1854 to a nadir of 22 in 1864. Countering allegations that Foxes had acquired mange from Badgers *Meles meles*, Sir Alfred Pease (Blakeborough & Pease *loc. cit.*) felt that the reverse was the case, noting that "long ago [possibly the 1850s-60s, see Figure 2], Badgers thought to be immune or un-susceptible to mange, were introduced into fox hunting territories to clean mangy earths". Further, he noted that "there were plenty of mangy foxes" and "that badgers have had mange occasionally since the great mange scourge among foxes in our time" (referring to the 1890s).

Derwent: Referring to the country hunted by Mr Sherbrooke's hounds kennelled at Snainton, Bonnett (1912) noted that Foxes were "generally not as good as they used to be a generation or two ago thanks to mange …".

Holderness: The only record of mange was of one Fox out of 91 killed during the 1847/48 season; although the Fox was killed the "hounds would not or were not allowed to break it up" (Reynard, 1920). The series of annual kills per 100 days' hunting calculated for the Holderness Hunt for the period 1844/45 to 1885/86 (based on data in Reynard, 1920) was inconclusive in indicating effects of mange since full hunting statistics were unavailable after 1885, though the rise from 41 kills/100 days in 1859 to 104 kills in 1885 reflected a pattern of increment common to hunts prior to mange outbreaks.

Middleton: Figure 3, based on data from 1853 to 1907 in Simpson (*loc. cit.*) reveals a prolonged increase in kills per 100 days' hunting from 55.4 in 1853 to an all time peak of 163.3 in 1892. This preceded an outbreak of mange first noted in the 1893-94 season and was followed by a rapid population decline, descending to a nadir of 78.5 kills per 100/dh in 1899. Hunt records indicated a scarcity of Foxes from 1900 to 1902, though rates began to recover in 1906.

York and Ainsty: Mange was noted on 1 March 1873 at Simpson's Wood and on 19 February 1874 and 25 March 1875 at Thorpe Green (SE4659). Kill rates, which had been at 83.6 per 100 days' hunting in 1872, dropped to 66.6 in 1874 and mean distances between finds increased from 2.6km in 1872 to 3.5km in 1873. This suggests that mange coincided with a slump in kill rates and a concomitant increase in distances between finds. This outbreak of mange had evidently died out by 1886 when Mr Edward Lycett Green (the new Hunt Master) paid tribute to the "good and stout" quality of the Foxes (Simpson, *loc. cit.*).

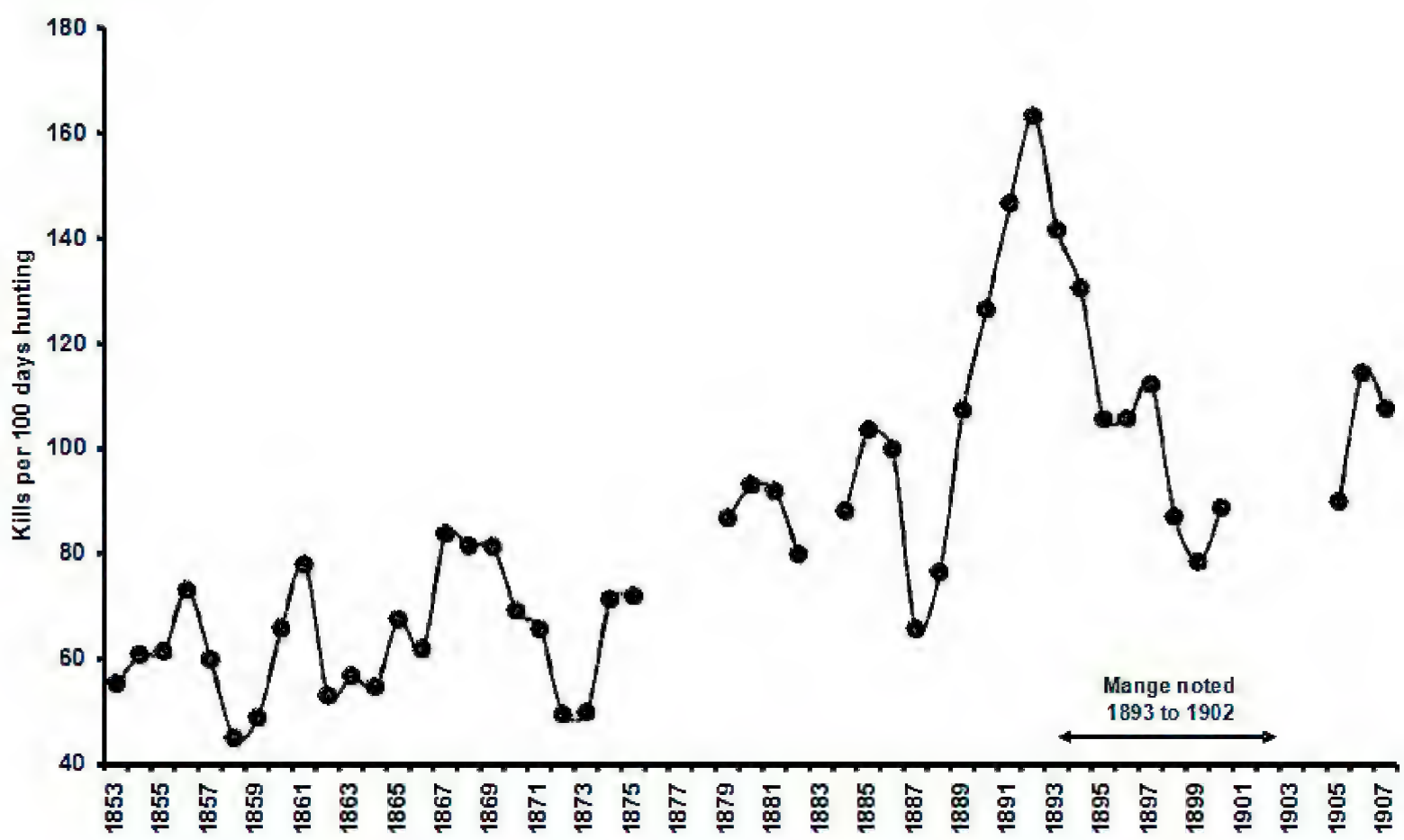

Figure 3. Numbers of foxes killed per 100 days hunting by the Middleton Hunt 1853 to 1907 (Calculated from data in Simpson, 1927).

Under Lycett Green the annual kill rates progressively rose from a nadir of 58 in 1888 to a peak of 93 in 1891 when the mean distance between finds was 2.8km. However, on 27 January 1892 a mangy Fox was encountered in Overton Wood (SE5457) (Dixon, 1899) and by early January

1894 Lycett Green found it necessary to write the following letter to the hunt committee on the increasing scarcity of Foxes: "For the first time during the eight years I have had the hounds, I am sorry to report a scarcity of foxes in the country. We have had mange now for three years and no doubt this must partly account for the dearth of foxes. Various means have been tried to stamp it out, without avail ...The only plan left I can now think of is for all land-owners, covert-owners and others to co-operate and permanently stop all their earths before the breeding season. In cases where mangy foxes have been known to use earths, to destroy and disinfect the soil with lime. By this, I hope the healthy foxes will make new earths and the mangy ones will be easily killed" (Dixon, 1899). On 11 December 1894 a fox with a touch of mange was found at Pickering Wood (SE5243) and on 26 March 1895 a fox with mange was found at Deighton. Mange clearly took a severe toll, figures calculated from the hunt records bearing out Lycett Green's field experiences, the annual kill rate having fallen to 60 by 1895 and "the scarcity of foxes caused the hounds to make very long draws before finding" (Dixon, 1899), the mean distances between finds having risen to 4km.

Comments by Naturalists: The Yorkshire Naturalists' Union Vertebrates Section report for 1901 noted, if prematurely, that "the gradual disappearance of mange amongst foxes must be a matter of congratulation. There is however, still a considerable amount of the disease prevalent in some districts. It has been a favourable breeding season for these animals and the enormous numbers of rabbits have caused parent foxes to have very little anxiety in providing food for their young" (Anon. 1901). The slow disappearance of mange was again reported in 1906 (Anon 1908a) and in 1908 "foxes in some districts were still affected with mange but the disease appears to be dying down rapidly" (Anon. 1908b).

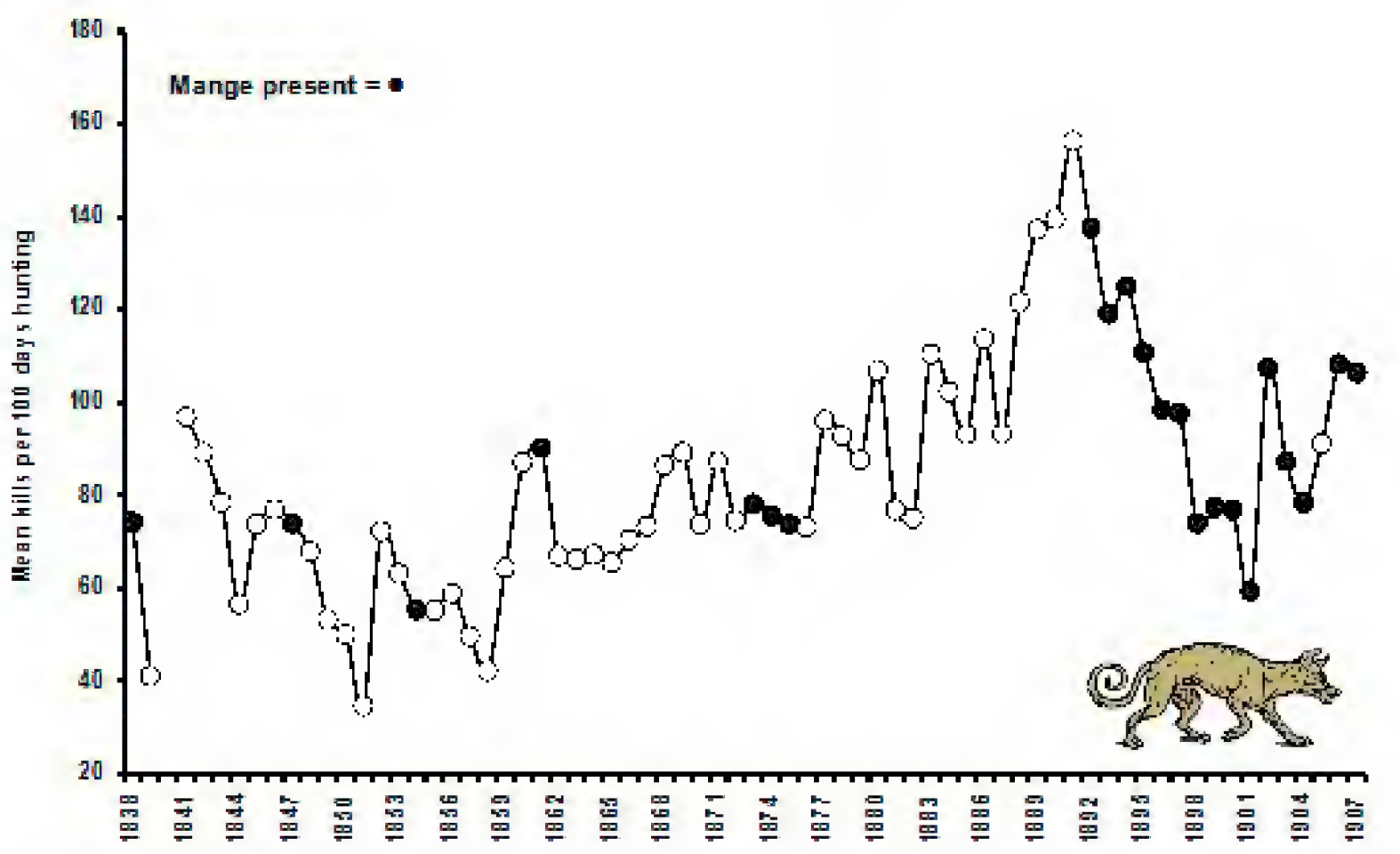

Figure 4: Relationship between fox density, as indicated by mean kills per 100 days' hunting calculated from all available Yorkshire data (1838 to 1907) and the reported incidence of mange.

Occurrences of mange in hunts elsewhere in England

In order to place the timing and performance of the Yorkshire mange outbreaks in a national context, the histories of a further 20 hunts across England have been examined for comparative evidence. Details of this investigation are given in Howes (2009) and the temporal trends reviewed in Figure 5. Mange was established in managed hunted populations in southern counties from 1887, peaking during the 1890s and dying out in 1900. It broke out in Yorkshire in 1892, peaked through the 1890s continuing till 1912 and presented in counties to the north of Yorkshire by 1902, dying out after 1914.

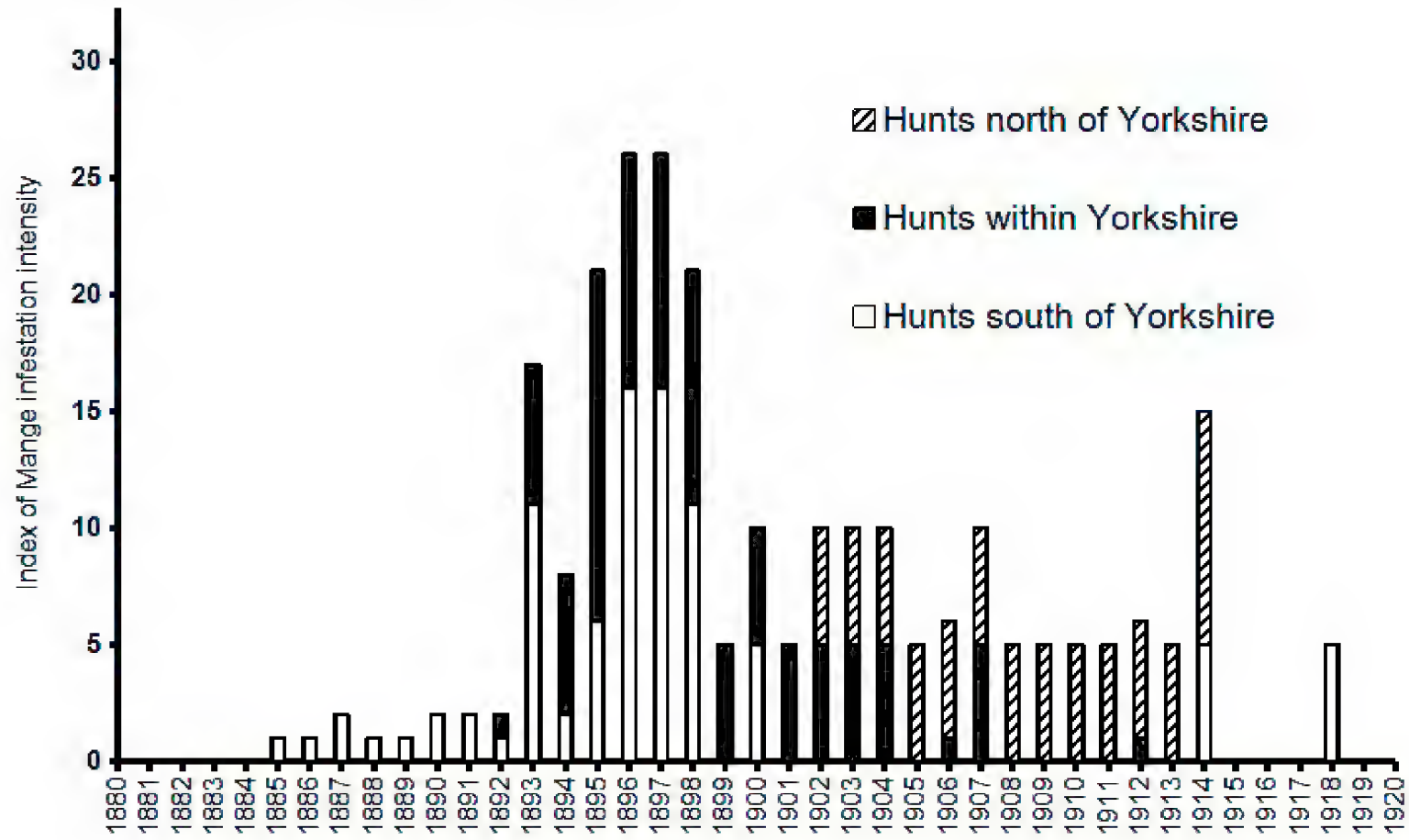

Figure 5: Mange occurrence and intensity in fox hunt territories throughout England 1880 to 1920.

Referring to the 1912/13 season in the York area, Procter (1913) noted that Foxes had been plentiful, though it is sometimes thought that mange follows any abundance of foxes. Records seem to give colour to this idea since the disease has usually appeared after sequences of good or improving hunting seasons. Of artificial fox earths, Procter (*loc. cit.*) suggested these are a frequent cause and venue of overcrowding.

Possible causes of mange outbreaks

Weather: The possibility of weather conditions affecting population levels is frequently referred to in the hunting literature. Speculation as to the cause of the epizootic ranged from the occurrence of prolonged hot and dry to cold and dry conditions (Tozer 1916). Hunts reported mange occurring as an added problem after periods of dry weather, when scent trails were difficult for the hounds to follow. It is possible that dry conditions could have raised the survival rates of cohorts of fox cubs by reducing the problems of hypothermia exacerbated by soaking fur or being flooded out of low-lying earths.

In order to identify any meteorological conditions which coincided with incidences of mange, the detailed season by season historical weather analysis provided by Bedford (2005) was compared with the 80 seasons (winters, springs, summers and autumns) of the 20 years

(between 1825 and 1912) when mange was noted in Yorkshire.

The peak decades of mange did indeed coincide with some extreme weather conditions. The very hot summer of 1893 produced a 73 day drought and 1899 was another notably hot summer. 1894 produced an extremely cold winter with record low temperatures and 1902 and 1907 had produced particularly cold summers. However, figure 6 suggests that these conditions only randomly coincided with incidences of mange. 15 (19%) mange seasons were "warmer than average", 22 (27%) were "colder than average" but in the majority, 43 (54%), seasons when mange was present the weather conditions were deemed to be "average".

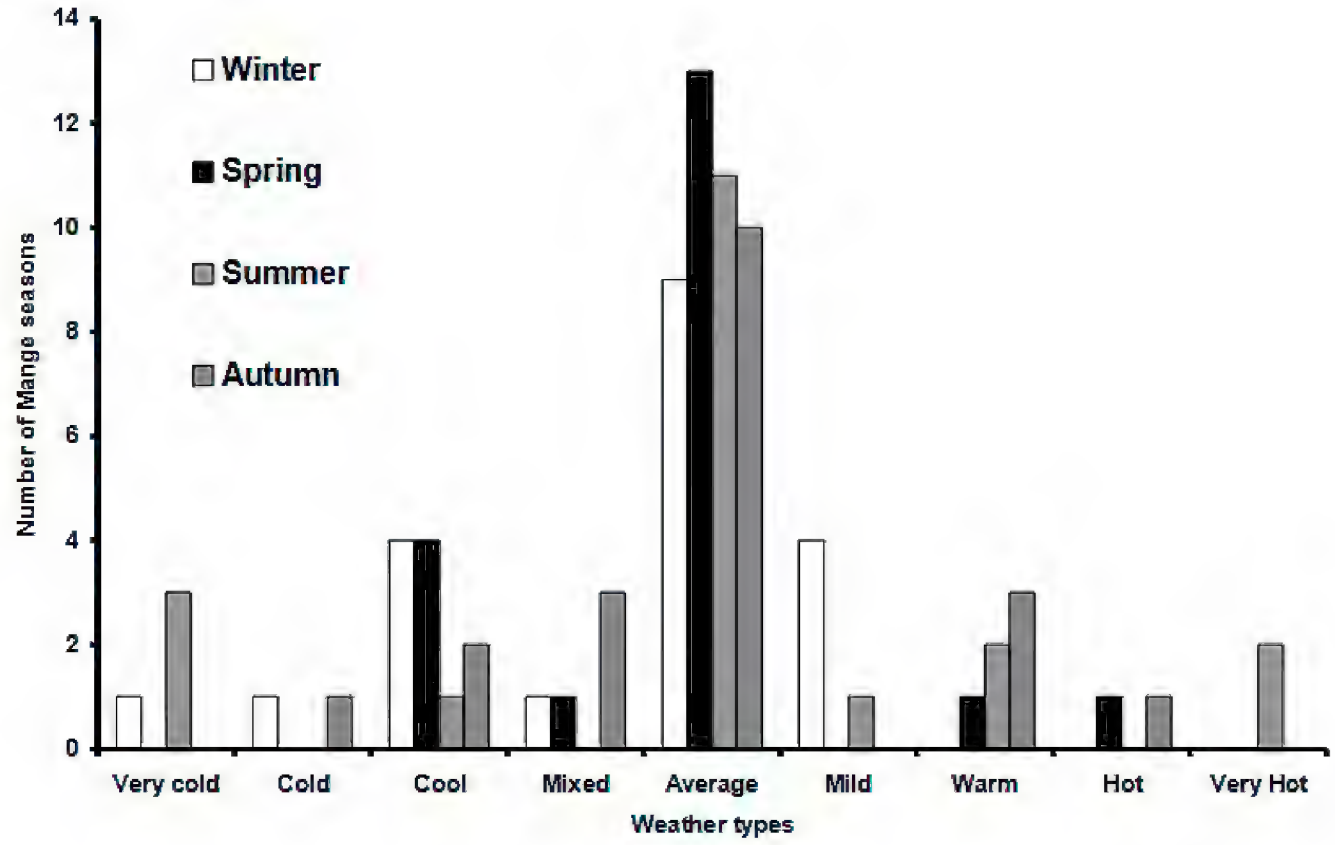

Figure 6: Relationship of incidences of mange in Yorkshire with prevailing weather conditions.

Food availability: The late 19th century saw an increase in game-rearing, largely for pheasants, but also partridge and, in upland areas, grouse shoots with an associated growth in the intensity and sophistication of game-keeping. Since an important function of game-keepers was to suppress the numbers of predatory bird and mammal species (except Foxes), one could expect a responsive increase in the population density of prey species such as rodents and lagomorphs. Fox populations were jealously guarded by hunts, even to the extent of holding "courts" to admonish those responsible for fox snaring, their elevated populations would therefore have had preferential access to otherwise un-predated rodent and lagomorph populations. It is therefore unlikely that starvation would have been a universal problem at this time.

Breeding site availability and Fox husbandry: One could surmise that with the maturation of numerous specially designed/planted fox covert woodlands and the thousands of miles of hedgerows and field drains created in response to the numerous 18th and 19th century enclosure awards across Yorkshire, a substantial number of additional Fox earth sites would have become available and protected populations would have substantially increased at this time. Procter (*loc. cit.*) speculated that an artificially high Fox population, fostered by over efficient fox-rearing/husbandry through the provision of artificial earths, encouraged close proximity of

individuals, facilitating the spread of the mite-borne disease. Certainly, anecdotes and analyses of hunting statistics provide evidence that throughout Yorkshire, and evidently across England populations, as expressed in terms of kills per 100 days hunting, were increasing progressively through the 1880s and 1890s, with some of the highest figures recorded in living memory or in the documented histories of the respective hunts.

Summary and discussion

By examining the extensive literature on fox hunting in the English counties it has been possible to reveal long term trends in kill statistics and find distances. To this has been added numerous specific dated and localised anecdotes of mangy foxes. Together, these data sets have revealed a major mange epizootic in managed fox populations across England during the late 19th and into the first decade into the first decade of the 20th century. In managed fox hunts across Yorkshire, the mean annual kill rate (per 100 days' hunting per year per hunt) progressively increased from around 65 through the 1860s, peaking at 156 in 1891 before collapsing to a mange-induced nadir of 59 in 1901 (see figure 4). Figure 5 indicates that across England a northerly progression of the epizootic took place, presenting in Home County, southern and midland hunt territories from 1888 to 1900, through Yorkshire from 1892 to 1912 before presenting in counties to the north of Yorkshire by 1902 and finally dying out after 1914.

Various causes for outbreaks have been claimed by hunt managers and rural commentators; these included extreme weather conditions, food availability and artificially high fox populations leading to the over-use of fox earths. In the cases of the Bramham, Cleveland, Middleton and York and Ainsty hunts, peak years were followed by mange-induced population crashes (see figures 1, 2, 3 & 4). Of the circumstances suspected to have promoted mange, high Fox population levels necessitating the constant re-use of soiled denning sites, would seem to be the most likely situation to promote the transmission of mange mites.

During the 1940s Australian epizootic, Rolls (1969) noted that there was little breeding during the period when the disease was prevalent. This coincides with the experiences in the York and Ainsty hunt during the 1894 mange epizootic, the hunt master reporting "I did not find the litters of cubs I expected during cub hunting nor have they turned up since" (Dixon, 1899).

20th Century Fox: a withering tail piece

There have been at least four outbreaks reported in rural Britain in the 20th century, these taking place along the south coast of England 1914; south-west England 1918; west Midlands and Wales 1931; and Sussex/Surrey border intermittently since the 1940s (Vesey-Fitzgerald, loc. cit.; Teagle, 1976; Burrows, 1968; Lloyd, loc. cit.; Soulsbury et al., 2007). Other examples of mange decimating Fox populations are given by Ratcliffe (1956) when, in Australia from 1940 to 1950, the imported Fox population was reduced by 80%, Lindhart (1960) working in New York State described a case where mange also brought about an 80% reduction in Fox density. Similar mange-induced rates of decline have affected Fox populations in Sweden (Mörner, 1992) and in Spain (Gortázar et al., 1998). Celebrated work on urban Fox populations in Bristol showed that during the sarcoptic mange outbreak from May 1994 to spring 1996 an estimated 95% of the Fox population had died (Baker et al., 2001).

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Aquatic plants in the canal known as Beverley Beck: effects of dredging and installation of pre-planted coir rolls in 2003-2004 and the aftermath to 2020

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Introduction

Beverley Beck (in VC61 South-east Yorkshire) extends from Beck Head in Beverley, East Yorkshire, eastwards for 1.25km to Grovehill Lock where it joins the River Hull. In its natural state the waterway was a tidal creek and from at least the Middle Ages was commercially important (Horrox, 1989). Significant improvements to benefit navigation were made in the 18th century and the waterway acquired its current form as a conventional canal in the first few years of the 19th century when Grovehill Lock was built and a constant, non-tidal, water level was established (Duckham, 1972; Grindell, 2008). Commercial navigation lasted into the 1970s. There is now occasional use by leisure boats, mostly at the extreme eastern end where there are moorings on the north side along the c.120m frontage of a former boat yard.

The water level is kept topped up by pumping from the River Hull. Historically, water was supplied by inputs from several lost watercourses that once flowed through the town and discharged into the beck. Grindell (*loc. cit.*) describes the rather uncertain origin and routes of these streams, which were formerly responsible for gross pollution. In the 1840s an inadequate town drainage system, associated with excess deaths from waterborne disease, discharged into the beck (Brown, 1989). Industry that developed around the beck (Beverley Guildhall Volunteers, 2007; Grindell *loc. cit.*) was also a source of pollution. In the mid 20th century tannery effluent caused the beck water to be black, anaerobic and stinking. The first annual report of the Yorkshire Ouse and Hull River Authority (Anon., 1966) describes how the inadequacy of the town's sewerage system led to continuous discharge of tannery and gelatine waste into the beck from December 1965 to March 1966. The beck was 'septic' and in summer 1965 Beverley Corporation installed jets to spray odour-masking compound over the malodorous water. Presumably, hydrogen sulphide was responsible for the bad smell. The River Authority's sixth annual report (Anon., 1971) tells us that up to March 1970 tannery waste overflowed from the town sewers and entered the beck almost daily. After March 1970, the tannery effluent was pumped directly to the town's new sewage works and the beck was reported as being substantially clean and oxygenated for the first time in about 40 years.

The final 30 years of the twentieth century saw substantial changes in the environs of the beck. The Grovehill Flyover (TA049393) was built to carry the new A1174 bypass over the waterway at c.440m east of Beck Head. Industrial premises were closed and demolished and were replaced by terraces of town houses built on both sides of the beck west of the flyover. The modern Grovehill Industrial Estate was built east of the flyover and north of the beck and is well shielded by trees. During the post-pollution years, the beck was colonised by water plants. For example, when I visited Beck Head in November 1997, up to the full width of the canal was covered by the floating fronds of Water Fern *Azolla filiculoides* and Common Duckweed while submerged plants included Rigid Hornwort. There was, however, a perception that the area needed improvement. A no-longer-available developer's website described the

beck as "A murky-looking stretch of water that had become a dumping ground for rubbish, a playground for vandals, an eyesore to locals and a tragedy for conservationists". Additionally, there was a reservoir of contamination in the sediments. Consultants engaged by the East Riding of Yorkshire Council showed a legacy of heavy metals, including arsenic and chromium, in silt that had accumulated over the years when industrial effluents were discharged into the beck (Anon., 2003). Consequently, a major programme of dredging and bank stabilization was undertaken on behalf of East Yorkshire County Council over the winter of 2003-2004.

Being then aware of the botanical interest of the beck, I recorded water plants in August 2003, before dredging took place. Subsequently, I investigated long-term recovery and/or change by continuing to make records every August until 2020. I surveyed the beck in two lengths: (1) along the c.440m west of Grovehill Flyover; and (2) along the c.810m east of the flyover. Palmer & Newbold's (1983) table of aquatic plants found in England and Wales was used as a checklist. Submerged/floating leaved plants and emergent plants were recorded separately; this helped presentation and interpretation. Obviously, this is sometimes an arbitrary division. Some plants, e.g. Arrowhead and Unbranched Bur-reed, mostly had submerged or floating leaves but were sometimes emergent. Others, e.g. Amphibious Bistort, were mostly emergent but sometimes had floating leaves. Where necessary a grapnel was used. Recording was loosely based on Holmes (1983). Water plants were identified and the abundance of each species was estimated using a 3-point scale: (1) occasional or rare (<0.1% whole-channel cover), (2) frequent (0.1-5% cover) or (3) dominant or abundant (>5% cover). A drawback of this approach is that it does not indicate whether a plant is widely scattered or locally concentrated. Thus, for example, a plant with 0.1-5% cover is described as frequent even if its distribution is very local. Plant names follow Stace (2019); scientific names are given in the text only if they do not occur in the tables. Tables 1 & 2, pp 47-50 give the results of the surveys. Additionally, some records of wetland and riparian plants were made although a specific checklist was not used.

Aquatic plants before dredging (August 2003)

Submerged and floating-leaved plants

In August 2003 the beck had crystal-clear water, submerged and floating-leaved vegetation was luxuriant (Figure 1, p39) and shoals of cyprinid fishes and lurking pike were easily seen. Towards Beck Head there was accumulation of silt which reduced the depth to as little as 0.3-0.5m; the silt was foul and stinking when disturbed by a grapnel. However, the biological richness of the beck suggests that potential toxins, accumulated in the silt, might have been bound to sediment particles or in other ways rendered biologically inert.

Submerged and floating-leaved plants were abundant throughout the canal; 15 species were found, and several were dominant/abundant (Tables 1 & 2). West of the flyover, Pondweeds (Potamogetonaceae) were conspicuous with >50% cover by Curled Pondweed and 20-30% by Broad-leaved Pondweed. Water-starwort was also dominant/abundant and six submerged/floating-leaved plants were frequent. Amongst the submerged plants were four alien waterweeds (Hydrocharitaceae); i.e. Large-flowered, Nuttall's, Canadian and Curly Waterweeds. East of the flyover, the floating leaves of Yellow Water-lily and Unbranched Bur-reed together covered up to c.80% of the surface, while Water-starwort and Spiked Water-milfoil were also dominant/abundant. Five submerged/floating-leaved plants were frequent; these included Coloured Water-lily (a pink-flowered hybrid cultivar of White Water-lily).

Emergent plants

West of the flyover emergent plants were sparse because of inhospitable margins of sheer masonry or sheet-steel piling. Only seven emergent plants were found, none was dominant/abundant and only Branched Bur-reed was frequent. In contrast, east of the flyover the banks were graded or of old broken-down piling, and there was conspicuous marginal vegetation of principally Reed Sweet-grass and Branched Bur-reed. Nine other emergent plants were found amongst which Lesser Pond-sedge and Amphibious Bistort were frequent. Wetland and riparian plants (not considered here to be aquatic) included widespread Great Willowherb and also Water Figwort and Marsh Woundwort.

Bank stabilisation, dredging and installation of coir rolls (winter 2003-2004)

Stabilisation of banks followed by dredging began in September 2003 (Davidson, 2003). During the project (Figure 1) new sheet-steel piling was installed along much of the beck west of Grovehill Flyover. At Beck Head c.70m of relatively recent pre-existing brickwork was retained along both sides of the beck. Otherwise, new piling was installed in front of the existing masonry frontage, excepting limited lengths that were of concrete or already had steel piles. The new piling was driven about 1m in front of the old masonry margin, resulting in a somewhat narrowed, sheer-sided, channel. A concrete coping was applied to the piles and the gap behind them was backfilled. Subsequent removal of silt from the channel was completed by late 2003-early 2004.

East of the flyover the works were less intensive. Mostly, silt was removed from the central channel but not right up to the margins. Therefore, the fringing emergent vegetation and rhizomes of Yellow Water-lily close to the bank were kept. David Dews of Pell Frischmann Consulting Engineers, Wakefield, who was involved in the project, informed me that the aim had been to remove as much silt as possible but without destabilising the banks.

In addition to the works described above, coir rolls that had been pre-planted with emergent and riparian plants were laid down along two lengths of bank with the aim of establishing marginal vegetation. These lengths were (1) west of the flyover on the south bank from TA04843930 eastward along c.50m of margin to c.20m west of the flyover and (2) east of the flyover on the north bank from TA05353931 eastward for c.150m to just short of the fence that bounds the boat yard. Along these lengths the bank was graded and sloped gently down to sheet-steel piles that had been driven to water level or just below.

The specification obtained from Pell Frischmann Consulting Engineers required two parallel rows of 30cm diameter coir rolls to be laid and secured, semi-submerged, behind the piles. The rolls were to arrive on site in March-April 2004. 80% of them were to be pre-planted while the rest were to be planted with plugs on site. The plants specified are listed in Table 3 and the required proportion of each in the planting mix is given. Some plants that are often dominant in the margins of rivers and canals were specified at a high proportion (15%), i.e. Reed Sweet-grass, Reed Canary-grass and Branched Bur-reed. Additionally, Greater Tussock-sedge was specified at 15%. Others, which are often less important marginal plants, were required to be at a lower proportion, e.g. Yellow Iris (8%) and Water-plantain (2%).

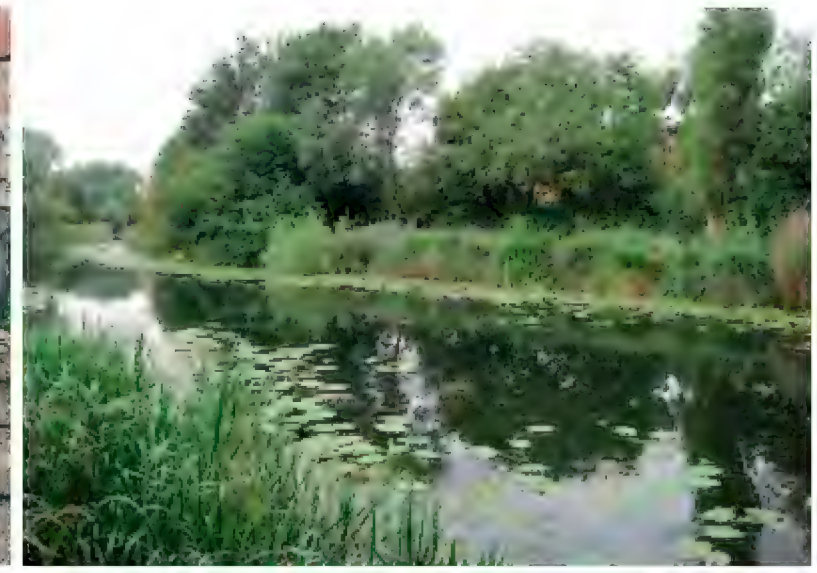
Disturbance throughout the piling and dredging operations caused the beck water to be extremely turbid because of abundant suspended solids. Also, uprooted vegetation accumulated

as rafts at the surface, mostly Reed Sweet-grass and rhizomes of Yellow Water-lily. The water remained murky through spring and summer 2004.

Aquatic plants soon after dredging (August 2004)

Submerged and floating-leaved plants

These plants were much reduced in August 2004. West of the flyover, none remained dominant or abundant and only Common Duckweed, Yellow Water-lily and Broad-leaved Pondweed were frequent (i.e. 0.1-5% cover). This contrasted greatly with the previous August when nine submerged/floating-leaved plants were dominant/abundant or frequent (Table 1, p47). Most were now found only as loose fragments amongst wind-driven floating litter of cans, bottles, plastics, and timber that accumulated at Beck Head.



Left: Figure 1. Abundant submerged and floating-leaved vegetation in Beverley Beck, west of Grovehill Flyover, before dredging; seen here looking west towards Beck Head, August 2003.

Right: Figure 2. In the eighth year after dredging, water is turbid and west of the flyover submerged and floating-leaved vegetation has largely not recovered; sparse floating leaves of Yellow Water-lily are in the foreground, sheer sides exclude marginal plants, August 2011.

Left: Figure 3. East of the flyover, emergent marginal vegetation and Yellow Water-lily survived dredging; Reed Sweet-grass is in the left foreground, the emergent vegetation on the far (north) side has arisen from pre-planted coir rolls, August 2018.

Right: Figure 4. Marginal vegetation developed from pre-planted coir rolls along c.50m of the south side of the beck, immediately west of the flyover; Greater Tussock-sedge and Purple-loosestrife are conspicuous, August 2016.

Only Yellow Water-lily and Broad-leaved Pondweed were seen as rooted plants and then only as small surviving patches of area <1m^2. More than 30 unproductive grapnel hauls confirmed the absence of rooted submerged plants in the turbid water.

Submerged and floating-leaved plants were also notably less abundant east of the flyover (Table 2, p48). The floating leaves of Yellow Water-lily covered barely more than 5% of the surface compared to approaching 80% in the previous year. No other submerged/floating-leaved plants were dominant/abundant. The formerly dominant/abundant water-starworts, Spiked Water-milfoil and Unbranched Bur-reed were reduced to frequent or occasional/rare status. Essentially, there were a few scattered patches of these plants discernible in somewhat turbid water. The sparsity of submerged vegetation was confirmed by more than 30 randomly thrown grapnel hauls being unproductive, except for two or three that retrieved a few shoots of Curled Pondweed.

Emergent plants

Emergent plants were essentially absent along the margins of raw new sheet-steel piling that now lined most of the beck west of the flyover. Emergent plants that were recorded (Table 1) were in atypical situations. Reed Sweet-grass and Water-cress were amongst rafts of floating vegetation that appeared to have originated from plants dislodged during dredging. Amphibious Bistort had established behind piling. Additionally, emergent plants were establishing in the coir rolls that had been laid on the south bank west of the flyover.

In contrast, emergent plants east of the flyover remained abundant and diverse (Table 2, p48). Marginal vegetation had largely survived dredging. Reed Sweet-grass continued to be dominant; Lesser Pond-sedge, Yellow Iris, Water-cress, Amphibious Bistort, Reed Canary-grass and Branched Bur-reed were frequent and seven other emergent plants were occasional/rare. However, some of these occasional/rare plants were found only in the newly laid coir rolls on the north bank.

Table 3. List of plants specified to be pre-planted, or planted on-site as plugs, in coir rolls used for bank consolidation in Beverley Beck, March-April 2004*

Emergent aquatic plants	**Wetland, riparian and other plants**
Alisma plantago-aquatica Water-plantain (2%) *Carex paniculata* Greater Tussock-sedge (15%) *Glyceria maxima* Reed Sweet-grass (15%) *Iris pseudacorus* Yellow Iris (8%) *Phalaris arundinacea* Reed Canary-grass (15%) *Sparganium erectum* Branched Bur-reed (15%)	*Agrostis capillaris* Common Bent (4%) *Alopecurus pratensis* Meadow Foxtail (4%) *Angelica sylvestris* Wild Angelica (5%) *Cirsium palustre* Marsh Thistle (1%) *Deschampsia cespitosa* Tufted Hair-grass (2%) *Eupatorium cannabinum* Hemp-agrinomy (5%) *Filipendula ulmaria* Meadowsweet (5%) *Lycopus europaeus* Gypsywort (3%) *Lythrum salicaria* Purple-loosestrife (3%)

*Information supplied by Pell Frischmann Consulting Engineers, Wakefield.
Values in brackets are the percentage of the planting mix to be represented by each species (it is noted that their sum is 102%).

Plants in coir rolls

By August 2004 the plants in coir rolls on both sides of the flyover were growing well. Reed Sweet-grass and Reed Canary-grass were conspicuous with other emergent aquatic plants and wetland/riparian plants amongst them, listed in Table 4, p50. Many of these had not been recorded in the previous August. Amongst these apparent newcomers were the emergent aquatic plants Water-plantain, Greater Tussock-sedge, Lesser Spearwort, Celery-leaved Buttercup, Blue Water-speedwell and Brooklime and the wetland/riparian plants Angelica, Nodding Bur-marigold, Monkeyflower and Purple-loosestrife. There appears to have been some deviation from specification. Lesser Spearwort, Celery-leaved Buttercup, Blue Water-speedwell, Brooklime, Nodding Bur-marigold and Monkeyflower were additional to the specified planting mix (Table 3).

Aquatic plants in the long-term following dredging (2005-2020)

Submerged and floating-leaved plants

West of the flyover, submerged and floating-leaved plants failed to regain their former abundance (Table 1). The pre-dredging state of crystal-clear water with highly visible, diverse and luxuriant submerged plants was, regretfully, not regained (Figure 3). By August 2005-2007, the lingering floating remnants of pre-dredging vegetation, still there in August 2004, had dispersed. No submerged or floating-leaved plants were dominant/abundant or frequent. Over the following years, 2008-2020, Yellow Water-lily came to fluctuate at around 5% cover. Otherwise, Canadian Waterweed, Spiked Water-milfoil, Curled Pondweed and Unbranched Bur-reed achieved frequent status (0.1-5% cover) but only in one or a few years. Only Curled Pondweed reached >5% cover, but only in 2018. This was a great contrast to the pre-dredging state west of the flyover in August 2003 when nine submerged/floating-leaved plants were dominant/abundant or frequent.

East of the flyover the water also generally remained more turbid and, although submerged/floating-leaved plants were more successful than west of the flyover, they were diminished when compared to the pre-dredging state (Table 2, p48). The floating leaves of Yellow Water-lily increased from c.5% cover soon after dredging in August 2004, to c.50% by 2007 and remained abundant to the extent that by summer 2020 the plant needed to be cut to benefit angling. Otherwise, submerged/floating-leaved plants tended to be less plentiful than before dredging. Water-starworts, dominant/abundant before dredging was afterwards only frequent (0.1-5% cover) or occasional/rare. Spiked Water-milfoil, although once again recorded as dominant/abundant in 2005, was subsequently occasional/rare, except it was not found in 2012 and 2020. Unbranched Bur-reed, dominant/abundant in 2003, was recorded as only frequent or occasional/rare throughout 2005-2020. Other submerged/floating-leaved plants were intermittently recorded as frequent. Amongst these were Rigid Hornwort, Nuttall's Waterweed, Common Duckweed, Coloured Water-lily, Broad-leaved Pondweed, Arrowhead and Fennel Pondweed.

Large-flowered Waterweed and Curly Waterweed, that were in the beck in August 2003, were not re-found in 2004 nor had they reappeared by 2020 (Tables 1 & 2, pp47-50). In contrast there were some submerged/floating-leaved plants that were not found before dredging but appeared during the years afterwards (Tables 1 & 2). For example, Flat-stalked Pondweed was first seen in 2012 and was then recorded every year from 2014 to 2020. Greater Duckweed was not found until 2017 but was there in subsequent years. A single plant of Water-soldier was

found in 2016, east of the flyover, and two vigorous plants were found west of the flyover in 2020.

Emergent plants

In the years following dredging emergent plants west of the flyover (Table 1, p47) continued to be generally sparse because of deep water and sheer margins. Minor exceptions were that by 2020 scattered plants of Branched Bur-reed had established in shallower water towards Beck Head and occasional plants of Greater Tussock-sedge, that had spread from the coir rolls, had found a toehold in irregularities of the vertical margin. Essentially, however, emergent plants continued to be confined to the site of the coir rolls on the south side of the beck immediately west of the flyover.

In contrast, east of the flyover, while emergent plants in coir rolls were a notable feature, the emergent marginal vegetation which had survived dredging also continued to thrive (Table 2, p48). Reed Sweet-grass persisted as the principal emergent plant (Figure 4, p39). Branched Bur-reed remained important although from year to year records fluctuated between dominant/abundant and frequent. Also, Yellow Iris and Amphibious Bistort were usually conspicuous, especially along the south side. The wetland/riparian Great Willowherb was also an important marginal plant on the landward side of the Reed Sweet-grass, again notably along the south bank. However, Lesser Pond-sedge which had been frequent, having been established along a stretch of the north bank in 2003 and 2004, decreased to being occasional/rare and in some years became difficult to find – it appeared to have suffered from shading by encroaching willows and perhaps from competition by Reed Sweet-grass. Flowering-rush is an emergent plant that was first recorded in 2014 at the far east end of the beck, approaching Grovehill Lock, where a single rooted non-flowering clump, c.50cm x 30cm, was found. By 2020 this had become a flowering stand c.3m x 1.5m and there were other scattered plants.

The post-dredging data for east of the flyover (Table 2, p48) include records made in the former boat yard on the north bank close to Grovehill Lock. In this area, to which there is no public access, there are about 10 jetties that jut out into the canal with boats moored alongside. Boats are also moored at the beck margin and in a small (c. 27m x 7m) dock. This area, with sheltered pockets alongside boats and in the dock, proved to be a good place to find water plants and appeared to be something of a refuge. It was the only place where Lesser Water-parsnip and Greater Pond-sedge were found. In some years, plants were found there but not elsewhere, e.g. Water Forget-me-not in 2008 and 2009, Celery-leaved Buttercup in 2007 (and the floating fronds of Ivy-leaved Duckweed in 2007 and 2008).

Plants in coir rolls

Emergent plants arising from the coir rolls laid down on both sides of the flyover continued as a prominent feature throughout 2005-2020 (Table 4, p50). By 2005 the beck margins where coir rolls had been laid down were occupied by a continuous stand of emergent vegetation, c.1-2m wide and 1-1.5m in height. This persisted (Figure 5) and tended to become wider and taller, except towards the east end of the stretch east of the flyover where, in later years, there was increased shading by trees and shrubs planted around the time of dredging.

Initially, Reed Sweet-grass and Reed Canary-grass were the most important components of the coir-roll vegetation but, more recently, Greater Tussock-sedge has developed its characteristic

tussocks and has become more prominent (Figure 4, p39). It has also spread to other parts of the beck. Other plants that were initially included in the coir rolls, either intentionally (Table 3, p40) or apparently inadvertently, continued to thrive. These included the aquatic plants Yellow Iris and Branched Bur-reed (although both were recorded elsewhere in the beck before dredging) and the wetland/riparian plants Garden and Wild Angelica, Pendulous Sedge, Meadowsweet, Hard Rush and Purple-loosestrife (Table 4, p50). However, some plants that were apparently new to the beck and were recorded in the coir rolls in 2004 or 2005 soon after installation, were not found in following years. These very transient plants included the aquatic Water-plantain, Soft Rush and Lesser Spearwort and the wetland/riparian plants Nodding Bur-marigold, Monkeyflower and Toad Rush. Other plants, not initially recorded in the coir-roll vegetation, were found in later years. These included Water Forget-me-not from 2011 and a lone plant of Altar Lily that has persisted since 2014.

Turbidity, phytoplankton and inorganic nutrients

Re-suspended silt observed during the dredging operations settled out during 2004. Nevertheless, during 2005-2020 turbidity in August appeared generally to be greater than before dredging. There was, however, some variability with notably clear water in 2007 which coincided with a powerful and unusual clear water input at Beck Head. In most years, however, the water was greenish and turbid, suggesting that phytoplankton was abundant. This was confirmed by determination of phytoplankton chlorophyll in 2005-2009. Duplicate sub-samples of surface water (0.2-1.0 litre) were filtered through Whatman GF/C glass fibre filters, chlorophyll was extracted from the filters into hot 95% ethanol and its concentration in the extract was measured spectrophotometrically (Jespersen & Christoffersen, 1987). Chlorophyll-a concentrations usually were high (Table 5), sometimes >100mg m^{-3}, which are values indicative of hyper-eutrophic conditions (Wetzel, 2001). The clear water year (2007) was an exception. When phytoplankton was examined In August 2006 using a microscope after concentration by centrifuging of water samples, ovoid motile unicells (Chlorophyta) were abundant; also notable was a *Cyclotella*-like centric diatom.

Table 5. Phytoplankton chlorophyll-a (mg m^{-3}) in Beverley Beck in August, 2005-2009.

	2005	**2006**	**2007**	**2008**	**2009**
West of Grovehill Flyover	109	138	2.4	12	58
East of Grovehill Flyover	96	79	5.8	16	39

Table 6. Nitrate and phosphate in Beverley Beck water before and after dredging

	Before dredging 1995-2003	**After dredging 2004-2009**	**P**
NO_3-N (mg l^{-1})	6.1 (4.7-7.3) 0.83	5.8 (4.6-7.0) 0.96	NS
PO_4-P (mg l^{-1})	0.09 (0.03-0.14) 0.03	0.06 (0.03-0.09) 0.02	<0.1

Values are overall means for *n*=9 years before dredging and *n*=6 years after dredging. Mean values for each year were derived from 11-13 determinations made at about monthly intervals. Comparison between overall means was made using a two-tailed Mann-Whitney *U*-test (NS=*P*>0.1). Each overall mean value is followed by the range of annual mean values (in brackets) and the standard deviation. Data were provided by the Environment Agency.

Water analysis data for before and after dredging were provided by the Environment Agency, which took samples from immediately west of Grovehill Lock at roughly monthly intervals. PO_4-P concentrations tended to be less after dredging. Nevertheless, nitrate and phosphate concentrations were high in absolute terms both before and after dredging (Table 6, p43) being at concentrations associated with eutrophic fresh waters (Wetzel, *loc. cit*). The beck water was neutral-mildly alkaline with pH values usually between 7 and 8.

Discussion

Submerged and floating-leaved plants

Dredging of canals can be contentious. It inevitably causes short term damage and destruction to aquatic plants and to a broader spectrum of wildlife. In the longer term, however, plants are likely to recover. Indeed, dredging can be beneficial to wildlife by, for example, maintaining open water and restraining plant succession and by removing polluted sediments and sediment-bound inorganic nutrients, especially phosphorus (IWAC, 2008). Thus, when the Huddersfield Broad Canal was dredged throughout in 2002 the aquatic plants found afterwards, up to 2019, were thriving and much the same plants were there as before. Twenty-four out of 30 aquatic plants recorded before dredging were still there afterwards. Moreover, the internationally significant Floating Water-plantain *Luronium natans*, which was abundant before dredging, soon recovered afterwards (Goulder, 2020).

In Beverley Beck the impact of dredging proved to be greatest on the submerged and floating-leaved plant community. The pre-dredging clear-water community was essentially lost during the dredging operations and only recovered fitfully over the years up to 2020 – especially west of Grovehill Flyover. The pre-dredging luxuriance of submerged vegetation was not seen again. Nevertheless, 13 out of 15 submerged/floating-leaved plants that were recorded before dredging were found again afterwards (Tables 1 & 2, pp47-50), thus there was no wholesale loss of species. A post-dredging feature is that the water continued to be notably more turbid than pre-dredging, even though re-suspended silt observed during the dredging operations had settled out during 2004. Boat movements were too infrequent to be responsible for sustained water turbidity. However, the green hue of the water, together with chlorophyll determinations (Table 5, p43), suggested that phytoplankton was abundant.

Change between dominance by phytoplankton and dominance by rooted aquatic plants in fresh waters is sometimes related to dredging, the reason being that accumulated anaerobic silt releases inorganic nutrients, especially phosphorus, to overlying water and this stimulates phytoplankton growth at the expense of rooted plants. When silt is removed phytoplankton may be replaced by submerged plants. Moss, Madgwick & Phillips (1996) give examples of this from the Norfolk Broads and elsewhere. In Beverley Beck, however, the direction of change was in the opposite direction with decrease in abundance of submerged plants and increase in phytoplankton following dredging. This may be related to persistence of high availability of nitrogen and phosphorus in the water even after dredging (Table 6). The phytoplankton is likely to have reduced underwater light availability and inhibited photosynthesis and growth of submerged plants. It is notable that Yellow Water-lily, which has floating leaves that are indifferent to underwater light attenuation, soon recovered, especially east of the flyover.

The two submerged plants that were not found after dredging, Curly Waterweed and Large-flowered Waterweed, are aliens that reach UK fresh waters as releases or escapes from aquaria

or garden ponds. At around the time of dredging, Curly Waterweed occurred in ponds in VC61 but Large-flowered Waterweed appears to have been otherwise absent (Wilmore, 2000). Their loss from Beverley Beck reduces botanical interest but is not of conservation significance. Other submerged plants that survived dredging have been lost in recent years, for example Rigid Hornwort, not found since 2015, and Canadian Waterweed, not since 2016 (Tables 1 & 2, p47-50). Continuing turbidity and increasing competition from Yellow Water-lily may be relevant. Coloured Water-lily was recorded every year from 2003-2019 but not in 2020. It is likely, however, that its floating leaves and flowers were lost during weed cutting, done to benefit fishing, and that its rhizomes survive on the bottom.

In the years following dredging some new submerged/floating-leaved plants made their appearance. These included Flat-stalked Pondweed that was not seen before 2012 but is now regularly found. It is a plant of calcareous waters, mostly found in eastern England (Preston & Croft, 1997). It is vulnerable in England (Stroh, *et al.*, 2014) and was regarded as uncommon in East Yorkshire by Crackles (1990). However, its range may be broadening in VC61; Middleton & Cook (2015) in their *VC61 Rare Plant Register* believe it to be regionally secure, with more than 10 records. It occurs in drains in the River Hull Valley (Goulder, 2000, 2010) and it is likely that it reached Beverley Beck as loose shoots carried into the canal in feed water pumped from the river. Its colonization of the beck is positive from the perspective of conservation and may make a significant contribution to the plant's continuing success in VC61. The recent appearances in the beck of Greater Duckweed and Water-soldier are more problematical. Middleton & Cook (*loc. cit.*) consider Greater Duckweed to be regionally rare and Water-soldier to be regionally extinct. Colonization of canals by both these plants has, however, been associated with releases from aquaria and garden ponds (Goulder, 2019a) and this may be the source of these plants.

Emergent plants

Dredging had less impact on emergent plants than on submerged/floating-leaved ones (Tables 1 & 2). West of Grovehill Flyover, emergent plants were already sparse because of hard, sheer sides and the new sheet-steel piling installed during bank consolidation in late 2003 ensured that conditions continued to be unfavourable for these plants. The marked exception was where coir rolls had been installed. Otherwise, scattered emergent plants of Branched Bur-reed, able to root in deep water, managed some colonisation of the channel towards Beck Head. East of the flyover, because the marginal vegetation was largely retained during dredging, the pre-dredging emergent plants were able to survive. Thus, Reed Sweet-grass and Branched Bur-reed continued to be dominant/abundant or frequent and most emergent plants found before dredging continued to be found. In all, 11 of the 12 emergent plants recorded in the beck before dredging were found again afterwards. The exception was Marsh Marigold; occasional/rare on the south bank east of the flyover in 2003 but not re-found. This plant is frequent in East Yorkshire (Crackles, *loc. cit*) and its apparent loss is unfortunate but not of great conservation significance.

Colonisation by Flowering-rush east of Grovehill Flyover from 2014 is a positive feature. Crackles (*loc. cit*) describes this plant as infrequent in East Yorkshire. It appeared in the beck in the vicinity of the pumped inflow from the River Hull which is therefore the likely source of propagules – this plant is plentiful, especially in its submerged form, in Frodingham Beck and the River Hull upstream of Beverley (Goulder, 2019b).

Plants in coir rolls

The luxuriant marginal vegetation that has developed where pre-planted coir rolls were installed in early 2004 has become a valuable wildlife feature. Ideally when pre-planted coir rolls are used the plant mix should comprise species that are part of the natural flora of the waterway. For example, this was so when the Canal & River Trust used them for bank stabilisation, as an alternative to sheet-steel piling, on the Stainforth & Keadby Canal at Thorne. There the new flora in the coir rolls, which included Sweet-flag *Acorus calamus*, Reed Sweet-grass and Reed Canary-grass, largely comprised plants that were already in the canal and blended with the existing marginal flora (Goulder, 2017, 2019a).

Perhaps less appropriately, the plants specified for incorporation in the coir rolls used in Beverley Beck (Table 3, p40) were a mix of species native to the site and newcomers. Thus, while some plants that arose in the coir rolls (Table 4, p50) and continued to thrive were already in the beck (e.g. Reed Sweet-grass, Reed Canary-grass, Branched Bur-reed and Yellow Iris) others were not found before the installation of coir rolls. Greater Tussock-sedge was pre-eminent in this group. It has thrived in the beck and has extended its range beyond its original location in coir rolls. Middleton & Cook (*loc. cit*) regard this plant as regionally scarce and, in the beck, it is a striking addition to the local flora. Although Greater Tussock-sedge was found around Beverley in the nineteenth century (Crackles, *loc. cit*), reintroductions can be controversial (Carter, 2020) and it has the potential to out-compete other plants. I do not know if an ecological impact assessment was done before its introduction. The observation that some of the plants found in coir rolls (Table 4, p50) and apparently new to the beck were not on the list of plants specified for inclusion (Table 3, p40) suggests that biosecurity or compliance with specifications may have been lax.

Some of the plants newly introduced in coir rolls clearly found the beck to be an amenable habitat and continue to thrive (Table 4). Along with Greater Tussock-sedge this group includes Garden and Wild Angelica and Purple-loosestrife. Others, however, did not persist. The chemical and/or nutrient status of the water was probably unsuitable, or they succumbed to competition from more vigorous neighbours, e.g. Lesser Spearwort, which tends to be associated with acid conditions, and the alien Monkeyflower.

Conclusions

The 2003-2004 bank stabilisation and dredging project in Beverley Beck has had a legacy. Chiefly, submerged plants became less luxuriant, especially west of Grovehill Flyover. Increase in phytoplankton and turbidity may have contributed to this. Positively, however, the floating-leaved (Yellow Water-lily) and emergent marginal vegetation changed less. Emergent marginal plants that were sparse west of the flyover before dredging remained so, while east of the flyover the abundant marginal vegetation was largely unscathed. Few aquatic plants were lost; only three out of 27 water plants in the beck before dredging were not found afterwards. Amongst new plants that colonised, probably naturally, after dredging were the conservation-worthy Flat-stalked Pondweed and Flowering-rush. Amongst new plants that originated in pre-planted coir rolls, the success of Greater Tussock-sedge is striking. This, hitherto scarce native in East Yorkshire, adds botanical interest to the beck.

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I am grateful to David Drews of Pell Frischmann Consulting Engineers for information about the

dredging project, to the Environment Agency for water analysis data and to Paul Caygill, the Beverley Beck bailiff, for his support.

Table 1. Aquatic plants in Beverley Beck west of Grovehill Flyover in August, 2003-2020.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Submerged and floating-leaved plants																		
Callitriche sp. Water-starwort	■	○	○	·	○	○	○	○	○	○	○	○	○	○	○	○	·	○
Ceratophyllum demersum Rigid Hornwort	○	○	·	·	·	·	·	○	·	·	○	○	·	·	·	·	·	·
Egeria densa Large-flowered Waterweed	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Elodea canadensis Canadian Waterweed	○	○	·	·	·	·	·	○	·	·	■	·	·	○	·	·	·	·
Elodea nuttallii Nuttall's Waterweed	■	·	·	·	·	○	○	○	·	·	○	·	·	·	·	○	·	○
Lagarosiphon major Curly Waterweed	■	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Lemna minor Common Duckweed	■	■	○	·	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Lemna trisulca Ivy-leaved Duckweed	·	○	·	·	·	·	·	·	·	○	·	·	○	·	·	·	·	○
Myriophyllum spicatum Spiked Water-milfoil	■	·	·	○	·	■	■	■	○	○	○	■	○	■	○	■	■	○
Nuphar lutea Yellow Water-lily	■	■	○	○	○	■	■	■	■	■	■	■	■	■	■	■	■	■
Nymphaea x marliacea Coloured Water-lily	·	·	·	·	·	·	·	·	·	·	·	·	○	·	·	·	·	·
Potamogeton crispus Curled Pondweed	■	○	·	·	·	·	·	○	·	○	○	○	·	○	○	■	·	■
Potamogeton friesii Flat-stalked Pondweed	·	·	·	·	·	·	·	·	·	·	·	○	○	·	·	○	·	○
Potamogeton natans Broad-leaved Pondweed	■	■	○	·	·	·	·	○	·	·	·	○	·	○	·	○	○	○
Ranunculus sp.†	○	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Sagittaria sagittifolia Arrowhead	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	○
Sparganium emersum Unbranched Bur-reed	■	○	○	○	○	○	○	○	○	○	■	○	○	■	○	■	■	○
Spirodela polyrhiza Greater Duckweed	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	○	○	○
Stratiotes aloides Water-soldier	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	○
Stuckenia pectinata Fennel Pondweed	·	○	·	·	·	·	·	·	·	○	○	○	○	○	·	○	·	○
Emergent plants*																		
Agrostis stolonifera Creeping Bent	○	○	○	·	·	·	·	·	○	·	·	○	·	·	·	○	○	·
Alisma plantago-aquatica Water-plantain	·	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·

Carex acutiformis Lesser Pond-sedge	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	○	○	○
Carex paniculata Greater Tussock-sedge	·	·	○	○	■	○	■	■	■	■	■	■	■	■	■	■	■	■
Glyceria maxima Reed Sweet-grass	·	■	○	○	·	○	○	○	○	○	○	○	○	○	○	○	○	○
Helosciadium nodiflorum Fool's-water-cress	○	○	·	·	·	○	·	·	·	○	·	·	·	·	○	○	○	○
Iris pseudacorus Yellow Iris	·	○	○	○	○	○	○	○	○	·	○	○	○	○	○	○	○	○
Juncus effusus Soft Rush	·	·	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Myosotis scorpioides Water Forget-me-not	·	·	·	·	·	·	·	○	○	·	·	○	○	○	○	○	○	○
Nasturtium officinale Water-cress	○	■	·	·	·	○	·	○	·	·	·	○	○	·	○	○	·	○
Persicaria amphibia Amphibious Bistort‡	○	■	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Phalaris arundinacea Reed Canary-grass	○	■	■	○	○	○	○	○	○	■	■	○	○	○	○	○	○	○
Ranunculus flammula Lesser Spearwort	·	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Ranunculus sceleratus Celery-leaved Buttercup	·	·	·	·	·	·	·	·	·	·	·	○	·	·	·	·	·	·
Solanum dulcamara Bittersweet	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Sparganium erectum Branched Bur-reed	■	○	·	○	·	·	·	○	·	·	■	·	·	○	·	○	·	○
Veronica anagallis-aquatica Blue Water-speedwell	·	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	○
Veronica beccabunga Brooklime	·	·	·	·	·	○	·	○	·	·	·	·	·	·	·	·	·	·

(■) = dominant or abundant (>5% whole-channel cover), (■) = frequent (0.1-5% cover),
(○) =occasional or rare (<0.1% cover), (·) = not recorded.
*From 2004 includes emergent plants that arose from pre-planted coir rolls.
†An unidentified non-flowering Water-crowfoot; ‡sometimes with floating leaves.
Dredging was in winter 2003-2004.

Table 2. Aquatic plants in Beverley Beck east of Grovehill Flyover in August, 2003-2020.

Year	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Submerged and floating-leaved plants																		
Callitriche sp. Water-starwort	■	○	○	○	■	■	○	■	○	○	■	○	○	○	○	○	○	○
Ceratophyllum demersum Rigid Hornwort	■	○	○	○	○	○	○	■	■	■	■	■	○	·	·	·	·	·
Elodea canadensis Canadian Waterweed	·	·	·	·	·	○	○	·	·	·	○	·	○	·	·	·	·	·
Elodea nuttallii Nuttall's Waterweed	○	·	·	○	○	■	○	○	○	○	○	·	○	■	○	○	○	■
Lagarosiphon major Curly Waterweed	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·

Lemna gibba Fat Duckweed	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	○	·
Lemna minor Common Duckweed	■	○	○	○	■	■	■	○	○	■	■	■	■	○	■	○	○	○
Lemna trisulca Ivy-leaved Duckweed	·	○	·	·	○	○	○	·	○	○	·	○	○	·	○	·	○	○
Myriophyllum spicatum Spiked Water-milfoil	■	■	■	○	○	○	○	○	○	·	○	○	○	○	○	○	○	·
Nuphar lutea Yellow Water-lily	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Nymphaea x marliacea Coloured Water-lily	■	■	○	○	○	○	○	■	○	○	○	○	○	○	○	○	○	·
Potamogeton crispus Curled Pondweed	■	■	○	○	○	·	·	·	·	·	○	○	·	·	·	○	·	○
Potamogeton friesii Flat-stalked Pondweed	·	·	·	·	·	·	·	·	·	○	·	○	○	○	○	○	○	○
Potamogeton natans Broad-leaved Pondweed	■	○	○	■	■	○	○	·	○	○	■	■	○	○	■	■	■	■
Ranunculus trichophyllus Thread-leaved Water-crowfoot	·	·	·	·	·	·	·	○	·	·	·	·	·	·	·	·	·	·
Sagittaria sagittifolia Arrowhead†	·	·	·	○	○	○	·	·	○	·	○	·	·	○	○	○	○	?
Sparganium emersum Unbranched Bur-reed	■	■	■	■	■	■	○	■	○	■	■	■	○	■	■	■	○	■
Spirodela polyrhiza Greater Duckweed	·	·	·	·	·	·	·	·	·	·	·	·	·	·	○	○	○	○
Stratiotes aloides Water-soldier	·	·	·	·	·	·	·	·	·	·	·	·	·	○	·	·	·	·
Stuckenia pectinata Fennel Pondweed	○	○	○	○	○	○	■	■	○	○	○	○	○	■	■	○	○	○
Zannichellia palustris Horned Pondweed	·	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Emergent plants*																		
Agrostis stolonifera Creeping Bent	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Alisma plantago-aquatica Water-plantain	·	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Berula erecta Lesser Water-parsnip	·	·	·	·	·	·	○	○	○	○	○	○	○	○	○	○	○	○
Butomus umbellatus Flowering-rush	·	·	·	·	·	·	·	·	·	·	·	○	○	○	○	○	○	○
Caltha palustris Marsh-marigold	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Carex acutiformis Lesser Pond-sedge	■	■	○	○	○	○	○	○	○	○	·	○	·	○	○	○	○	○
Carex paniculata Greater Tussock-sedge	·	○	○	○	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Carex riparia Greater Pond-sedge	·	·	·	·	·	○	○	○	○	○	○	○	○	○	○	○	○	○

Glyceria maxima Reed Sweet-grass	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Helosciadium nodiflorum Fool's-water-cress	○	○	·	·	○	○	○	○	○	○	○	○	○	○	○	○	·	○
Iris pseudacorus Yellow Iris	○	■	○	■	■	○	○	○	○	■	○	■	■	■	■	■	○	■
Juncus effusus Soft Rush	·	·	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Myosotis scorpioides Water Forget-me not	○	·	·	·	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Nasturtium officinale Water-cress	○	■	○	·	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Persicaria amphibia Amphibious Bistort‡	■	■	■	■	■	■	○	○	○	○	■	■	■	■	■	■	○	■
Phalaris arundinacea Reed Canary-grass	○	■	■	■	■	○	○	○	○	■	■	■	○	○	○	○	○	■
Ranunculus flammula Lesser Spearwort	·	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Ranunculus sceleratus Celery-leaved Buttercup	·	○	○	·	○	·	·	·	○	·	·	○	○	·	·	·	·	·
Solanum dulcamara Bittersweet	·	·	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○
Sparganium erectum Branched Bur-reed	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Veronica anagallis-aquatica Blue Water-speedwell	·	·	·	·	·	·	·	·	·	·	·	·	·	○	○	·	·	·
Veronica beccabunga Brooklime	·	○	·	·	·	·	·	·	·	·	○	·	·	·	·	·	·	·

(■) = dominant or abundant (>5% whole-channel cover), (■) = frequent (0.1-5% cover),
(○) = occasional or rare (<0.1% cover), (·) = not recorded.
*From 2004 includes emergent plants that arose from pre-planted coir rolls.
†Sometimes emergent; ‡sometimes with floating leaves.
Dredging was in winter 2003-2004.

Table 4. Emergent aquatic plants and wetland/riparian plants associated with coir rolls, 2004-2020.

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Emergent aquatic plants																	
Agrostis stolonifera Creeping Bent	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Alisma plantago-aquatica Water-plantain*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Carex acutiformis Lesser Pond-sedge	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+	+
Carex paniculata Greater Tussock-sedge*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Glyceria maxima Reed Sweet-grass	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Helosciadium nodiflorum Fool's-water-cress	+	·	·	·	+	·	·	·	·	·	·	·	·	·	·	+	+
Iris pseudacorus Yellow Iris	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Juncus effusus Soft Rush*	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Myosotis scorpioides Water Forget-me-not	·	·	·	·	·	·	·	+	·	·	+	+	+	+	·	+	+
Nasturtium officinale Water-cress	+	·	·	·	·	·	·	·	·	·	·	+	·	+	·	·	+
Persicaria amphibia Amphibious Bistort	·	+	+	·	·	·	+	·	·	·	·	·	·	·	+	·	·
Phalaris arundinacea Reed Canary-grass	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ranunculus flammula Lesser Spearwort*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Ranunculus sceleratus Celery-leaved Buttercup*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Solanum dulcamara Bittersweet	·	·	·	·	·	·	·	·	+	·	·	·	·	+	·	·	·
Sparganium erectum Branched Bur-reed	+	+	+	·	·	+	·	·	+	+	+	·	+	+	+	·	+
Veronica anagallis-aquatica Blue Water-speedwell*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Veronica beccabunga Brooklime*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Wetland and riparian plants																	
Angelica archangelica/ sylvestris Garden/Wild Angelica*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bidens cernua Nodding Bur-marigold*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Carex pendula Pendulous Sedge*	·	·	+	+	+	+	+	+	·	+	+	+	·	+	+	+	+
Epilobium hirsutum Great Willowherb	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Erythranthe guttata Monkeyflower*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	
Filipendula ulmaria Meadowsweet	+	+	+	+	·	·	+	·	+	·	·	+	·	+	+	+	+
Juncus bufonius Toad Rush*	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Juncus inflexus Hard Rush*	·	+	+	+	+	+	+	+	·	·	·	·	·	+	+	·	+
Lycopus europaeus Gypsywort*	·	·	+	+	+	+	·	·	·	·	·	·	·	·	·	·	·
Lythrum salicaria Purple-loosestrife*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Scrophularia auriculata Water Figwort	·	·	·	·	·	·	·	·	·	+	+	·	·	·	·	·	+
Stachys palustris Marsh Woundwort	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·	·
Valeriana officinalis Common Valerian*	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Zantedeschia aethiopica Altar-lily*	·	·	·	·	·	·	·	·	·	·	+	·	+	+	+	+	+

(+) with infill = present, (·) = not recorded.

*Not recorded in the beck in August 2003 (before dredging).

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Freshwater Algae of the Knaresborough Dropping Well travertine, Yorkshire

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Introduction

The Dropping Well is a travertine- (calcareous tufa) depositing spring next to Mother Shipton's Cave close to the River Nidd in Yorkshire. The well has been used for centuries in the production of 'petrifactions' - objects placed in the water soon become encrusted in calcium carbonate and then sold as souvenirs. The spring rises in the Permian Middle Marl (Cooper & Burgess, 1993) capped by the Upper Magnesian Limestone and the groundwater probably acquires solutes in its passage through both formations. The Middle Marl contains evaporite deposits rich in calcium sulphate that are readily dissolved out into the groundwater and sometimes lead to the formation of large voids (Cooper *et al*., 2013). As a consequence, the Dropping Well water has high levels of calcium, sulphate and dissolved carbon dioxide, mainly as bicarbonate, the latter resulting in the reaction of soil carbon dioxide with the limestone. Upon emergence, some of the carbon dioxide is released to the atmosphere leading to the precipitation of calcium carbonate as travertine (Emeis *et al*., 1987) along with a small quantity of calcium sulphate. The loss of carbon dioxide from the water is enhanced by the presence of freshwater algae through their photosynthesis. This investigation describes the algae currently growing upon the travertine surface and compares it with some historic data from the site and some other travertine-depositing waters in the UK. Although several chemical analyses of these waters have been undertaken (Burrell 1896; Pentecost 1991; Cooper & Burgess 1993; Cooper *et al*., 2013) dissolved nutrients were not included. Some nutrient analyses are included in this article.

The first record of algae from the Dropping Well was published in Hassall (1845). He reported two species from the deposit, *Haematococcus allmanii* Hassall and *H. hookeri* Berkeley & Hassall.

The former being named in honour of the zoologist George Allman who collected the material. The dried material is preserved in the Hassall Herbarium at the Natural History Museum. This was examined by Drouet and Daily (1956) who could not confirm the identification as *Haematococcus* and concluded the material was 'uncertainly placed'. In fact, Hassall's figure of this plant resembles the red alga *Chroothece richterianum* known from several other travertine sites in the north of England. The above records were repeated in the Flora of Yorkshire (Lees, 1888) without further comment. Later, West and West (1901) reported three species of diatom from the Dropping Well in their *Alga-flora of Yorkshire* but there appear to have been no further reports until the present time.

The Dropping Well is an historically important location. It was here that John French experimented with the water and discovered that upon evaporation it left an earthy residue similar to the deposited calcium carbonate (French, 1654). He also weighed the water and found that it was slightly heavier than pure water owing to the substances dissolved in it. These were significant findings at the time when many competing hypotheses were attempting to explain the origins and properties of spring waters.

Methods

Samples were collected from different sites on the cliff face in June and October 2021 (main sites marked 1-4 in Fig. 1). The samples were examined under a light microscope for identification. Five collections were examined in detail (Table 1) using surface scrapes. Endoliths were sampled after decalcification with 3% ethylenediaminetetraacetic acid at pH 8. The samples were also examined for diatoms after cleaning with hot sulphuric acid and potassium chlorate followed by washing, drying and mounting in Naphrax. Diatom frustules were examined under oil at x 1250. In each sample, a minimum of 600 frustules were examined to provide relative abundance. Further small collections were made from other parts of the travertine apron and from the cave-like overhang and pool below and these also included bryophytes, ferns and flowering plants. A water sample was taken from the stream c. 15m above the cliff by the footpath and a partial analysis undertaken including some plant nutrients using methods described in Mackereth *et al*. (1978). Diatom nomenclature follows Cantonati *et al*. (2017).

Table 1. Sample descriptions (see also Figure 1, p57)

Sample code	Date collected	Description
C	15 June 2021	Composite sample scraped from the cliff surface, associated with *Cladophora*
1	14 October 2021	Dark green vertical streak near the south end of the cliff
2	"	Dark brown superficial patch near the cliff centre at base
3	"	Yellow-brown vertical streak towards the north end of the cliff
4	"	Large growth of Palustriella on a travertine boss in the cave below the cliff

Results and Discussion

The cyanobacteria and algae, consisting mainly of diatoms, are listed with their relative abundance in Table 2. A few further records of algae from other parts of the deposit were also made and are mentioned below. Cyanobacteria were conspicuous only in the more shaded

areas below the travertine apron where *Geitlerinema* and *Phormidium autumnale* Gom. occurred among the bryophytes in the running water. A partially endolithic *Leptolyngbya* was found on the apron itself but was not abundant. All of the above cyanobacteria belong to the Oscillatoriales which, on most British and European travertines, usually form an abundant encrusting community, but this is poorly developed at the Dropping Well, if at all. At a point just to the south of site 3 the cyanobacteria *Chroococcus turicensis* (Naeg.) Schmidle, *Gloeocapsa punctata* Naeg. and *Schizothrix* sp. were found, all in low abundance. The green algae fared better with *Cladophora* often abundant and partially encrusted with calcite. In sample C, collected in June (see Table 2), it was common and most of the associated algae were epiphytes. This sample was obtained by scraping the apron to clean it of excessive algae.

Table 2. Cyanobacteria and algae recorded from the Dropping Well.

Phylum/genus/species	West & West 1901	Site C June 2021	Site 1	Site 2	Site 3	Site 4
Cyanobacteria						
Geitlerinema splendidum (Grev. Ex Gom) Anag.						F
Leptolyngbya sp.			F	F	R	
Chlorophyta						
Cladophora glomerata (L.) Kuetz.		A	O	O	R	
Oedogonium sp.					R	
Spirogyra condensata group				F	F	
Ulothrix tenerrima (Kuetz.) Kuetz.				F	R	
Bacillariophyta (Diatoms)						
Achnanthidium minutissimum (Kuetz.) Czern	+	54.8	3.1	28.0	21.2	79.5
Amphora minutissima W. Sm.		+	+			
Brachysira cf. lilacina (Grun.) Ross						+
B. vitrea (Grunow) Ross		+		1.8	15.6	2.1
Caloneis sp.		+				
Cocconeis pediculus Ehrenb.		11.7				+
Clevamphora ovalis (Kuetz.) Meres.						+
Cyclotella sp.		+				
Cymbella cf. aequalis			+			
Cymbella helvetica Kuetz.	+					
C. neoleptoceros Krammer			20.7	55.9	24.6	3.9
C. cf. subaequalis			3.0			
Denticula tenuis Kuetz.		+				
Diatoma moniliformis Kuetz.		2.1				+
Diploneis elliptica (Kuetz.) Cleve					+	+
Encyonema caespitosa Kuetz.		+				
Encyonema minutum (Hilse) D.G.Mann		+				
Fragilaria capucina Desmaz.		2.0	+	+	+	

F. nanana Lange-Bertalot						7.4
F. vaucheriae (Kuetz.) Peters.		1.3				
Frustulia rhomboides (Ehrenb.) de Toni						+
Gomphonema clavatum Ehrenb.			58.8	13.7	35.1	2.1
G. minutum (C. Ag.) C. Ag.		1.2				
G. olivaceum (Hornem.) Breb.		12.0			+	+
Hannaea arcus (Ehrenb.) R.M. Patrick		+				
Melosira varians C. Ag.		1.3				
Meridion circulare (Grev.) C. Ag.		+				
Navicula angusta Grunow	+					
N. cryptocephala Kuetz.			2.9	+		1.3
N. gregaria Donkin		+				
N. lanceolata (C. Ag.) Ehrenb.		1.8				
N. recens (Lange-Bertalot) Lange Bertalot						+
Nitzschia dissipata (Kuetz.) Rabenh.			4.4			+
N. palea s. lat. (Kuetz.) W. Sm.		+				
N. sigmoidea (Nitzsch)W. Sm.		+				
N. sinuata (W. Sm.) Grunow		+				
Planothidium lanceolatum (Breb. ex Kuetz.) Lange-Bertalot		1.3				
Rhoicosphenia abbreviata (C. Ag.) Lange-Bertalot		3.0				
Surirella sp.		+				
Tabellaria flocculosa (Roth) Kuetz.						+
Ulnaria ulna (Nitzsch) Compere		+	3.6		+	+
Not identified		1.7	+	+	1.9	1.6

AFOR scale (abundant, frequent, occasional, rare) for non-diatom algae; for diatoms the percentage frequency is given with + for < 1%. See Fig.1 for sample locations.

Just to the left of site 2, decalcification revealed locally abundant *Vaucheria* sp., a member of the Xanthophyceae. Both *Cladophora* and *Vaucheria* are common travertine algae, particularly in waters enriched with nutrients. Diatoms were both numerous and diverse on the apron, with some species producing deep brown superficial streaks (Figure 1). Three species were particularly common: *Achnanthidium minutissimum*, *Cymbella neoleptoceros* and *Gomphonema clavatum*. *Achnanthidium* is almost ubiquitous on travertine throughout Europe. It is a small species so that although its numbers are often high, its contribution to the overall biomass is usually low. It is the only diatom that was also recorded by West and West in 1901. *Gomphonema clavatum* was found in considerable numbers in three of the sites. This species does not appear to have been recorded from travertine before, but several related species, e.g. *G. angustatum*, *G. angustum* and *G. olivaceum,* have often been recorded. *G. clavatum,* which has a wide tolerance to different environments, grew directly upon the travertine surface and among the moss *Palustriella commutata*. The remaining common species and, owing to its size, probably the most significant in terms of biomass, was *Cymbella neoleptoceros*. Detailed examination of this diatom on the travertine surface at site 2 revealed a density of

approximately 60,000 cells per cm^2. This diatom was seen slowly creeping over the travertine surface and formed a dull brown discolouration on the deposit. The species was described from the Plitvice Lakes in Croatia where travertines are abundant and it has been seen on travertine in southern Germany and Scotland.

The diatom flora of the encrusted *Palustriella* (site 4) was similar to that of the bare travertine although *Achnanthidium* was more abundant compared with other species and *Fragilaria nanana* was also of frequent occurrence. A study of the diatoms growing on a *Palustriella* travertine in Derbyshire (Pentecost, 1998) also revealed an abundance of *Achnanthidium*, but here the most important diatom was *Ropalodia*, which was not recorded at the Dropping Well. The diatoms of another moss, *Eucladium verticillatum,* occurring in a more shaded area of the Dropping Well overhang was dominated by species of *Nitzschia*.

Figure 1. The Dropping Well showing locations of the main algae sampling sites, 1-4

To what extent moss morphometry, water and light availability influence the species composition is not yet known. A total of 41 diatom species were identified at the Dropping Well which included *Diatoma moniliformis*, *Navicula lanceolata*, *Rhoicosphenia curvata* and *Cocconeis pediculus*. These four were associated closely with the *Cladophora* upon which they are well known epiphytes (Chudbya, 1965). Most of the remaining diatoms have been found on other travertines from time to time, but the 'constant' members belong to the genera *Achnanthidium*, *Cymbella* sensu lato and *Gomphonema*. The fundamental reasons for this are unknown but most members of these genera are widely recognised as 'alkaliphils', associated

with a pH in the region 7-8, corresponding to most travertine-depositing waters. These diatoms are also sensitive to nutrient enrichment, particularly to phosphorus, and it is interesting to note that *Achnanthidium* was found by the Wests over a century ago (West & West, 1901). This suggests that any enrichment of the spring waters feeding the Dropping Well has been limited over this time.

A partial water analysis, taken from a sample collected c.15m above the Dropping Well, is shown in Table 3. Levels of plant nutrients all indicate a good quality water and this is borne out by the low Biological Oxygen Demand. The only elevated value is that of the dissolved organic phosphorus. This form of phosphorus is available to some algae (Whitton & Neal, 2011) and may help explain the abundance of *Cladophora* along with the presence of *Vaucheria*, *Melosira* and some of the *Navicula* species.

Table 3. Dropping Well water analysis. Values apart from alkalinity and BOD in µg/litre.

Determinand	**Value**
pH	6.99
Biological oxygen demand (BOD_5)	1.0mg/L
Alkalinity	6.88meq/litre
Nitrate-nitrogen	625
Ammonia-nitrogen	<50
Orthophosphate phosphorus	10
Organically bound phosphorus	84

The underhang was colonized by bryophytes, ferns and flowering plants -- the former predominating and consisting of the mosses *Cratoneuron filicinum*, *Eucladium verticillatum* and *Palustriella commutata* and the liverworts *Conocephalum conicum*, *Leiocolea turbinata* and *Pellia fabronniana*. Also present were the fern *Phyllitis scolopendrium* and vascular plants *Hedera helix*, *Geranium robertianum* and an unidentified garden escape. All of the above, bar the escape, are known from other travertine deposits.

The Dropping Well travertine is seen to possess a rich and interesting flora which thrives despite regular cleaning of the apron to remove buildup of excessive algae. This success is partly the result of algae becoming incorporated into the deposit where they cannot be easily removed allowing a rapid re-colonisation. British travertines are recognized in having a specialised flora and being vulnerable to water pollution. Travertine formation is inhibited by phosphates, a major constituent of water pollution (Meyer, 1984;, Pentecost, 2017) and large deposits such as the Dropping Well are rare in Britain so it is important to monitor and conserve them.

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Frozen foods and fossil finds: Plesiosaur vertebral centra derived from the Frodingham Ironstone Formation at Holme, Lincolnshire.

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Introduction

On occasions, fossil remains may be found close to the surface of cultivated fields due to the weathering of the underlying bedrock combined with the soil-tilling activities of crop production. Aware of this phenomenon, the author's late father, referred to in this paper as A.J.P., was always keen to explore any potentially fossiliferous locations (see Phipps, 2018 for

further details on this topic). One such source came to his attention during his duties as the Health and Safety Officer of a major frozen food producer. In 1989, carrots were harvested from various localities in northern Lincolnshire in order to form part of the company's range of frozen vegetables and ready meals. As part of the harvesting procedure, any rock fragments or artefacts such as pieces of pottery or glass were separated from the carrot crop and deposited in a spoil heap. Whilst inspecting this facility, A.J.P. discovered the heap and subsequent investigations revealed the two specimens which are described in this paper. Consultations with the staff responsible for vegetable production led to the discovery of the field from which the carrots and their accompanying fossils had originated: a field close to Holme Hall near Bottesford, Lincolnshire (SE908070). A search of the area by A.J.P. and the author failed to produce additional specimens. It should be noted that the fossils have been through the carrot-harvesting machine and, therefore, show some damage.

Details of the site

The geology of the area from which the specimens came consists of the Lower Jurassic Frodingham Ironstone Member of the Scunthorpe Mudstones Formation covered by deposits of blown sand of the Sutton Sands Formation (British Geological Survey). The presence of the aeolian sands, which are thought to have been formed in a lacustrine environment during the Devensian Stage, is especially significant. These silty sands were deposited by wind action at the end of the last 'Ice Age' and, therefore, they could not be the source of the plesiosaur fossils. This could have been the case if the rocks were covered by glacial till. Also, from an agricultural perspective, the sands produced soils which were ideally suited to the production of carrots. It seems highly probable that the plesiosaur vertebrae originated from the underlying Frodingham Ironstone Member.

The Frodingham Ironstone Member consists of an “ooidal and richly bioclastic ironstone” (Simms, 2004. p.26) which is over 10m thick and was of vital economic importance in the development of Scunthorpe as a major steel producer. It is thought that the ironstone was laid down on a shoal isolated from the land and the environment was subjected to periods of wave or current action. In addition, phases of quiet and disturbed water were combined with alternating reducing and oxidizing conditions on the sea floor. The absence of a nearby shoreline is suggested by the fact that these deposits pass into marine shales to the north and south of the Scunthorpe district (Hallam, 1963, p.572).

Fossil remains from the Frodingham Ironstone Member include ammonites, belemnites, bivalves and echinoderms. The pioneering description of the ironstone by Cross (1875, pp 118-119) also features a full faunal list of the specimens discovered at that time (*op. cit.*, p.123). More recent details of the fauna have been provided by Hallam (1963), Knell (1988), Young *et.al.* (1990) and Page (2004). The ammonites present are of especial importance as they provide the means to establish the age of the Frodingham Ironstone Member. Page's detailed description of the Geological Conservation Review site at nearby Conesby indicates that the Frodingham Ironstone Member covers the Semicostatum, Turneri and Obtusum zones of the Lower and Upper Sinemurian stages (Lower Jurassic). Within these chronozones the following sequence of subzones has been identified: Sauzeanum, Brooki, Birchi; Obtusum Subzone absent; Sterrare and Denostatus (Page, 2004a, p. 221). The absence of the Obtusum Subzone is significant, as it suggests that a minor non-sequence is present (Hallam, 1963, p. 558). Radiometric ages have been established for the Sinemurian Stage: latest figures quoted by Hesselbo and King (2019)

indicate that the rocks of this period are between 191 ± 1.0 and 199.40 ± 0.3 Ma (million years) old. These rocks of the Lower Jurassic Series were traditionally known as the "Lower Lias".

At the time of deposition, Britain was between 30° and 40° north of the equator and formed part of a shallow seaway extending south-east into the Tethys Ocean and north-east towards the Arctic. Present-day Greenland and North America were positioned to the north and west. The Scunthorpe area formed part of the East Midlands Shelf separated from the Cleveland Basin to the north by the Market Weighton High (Simms, 2004. pp 20-21). The Frodingham Ironstone Member is restricted to the area around Scunthorpe, but contemporaneous strata do occur to the north of the Humber.

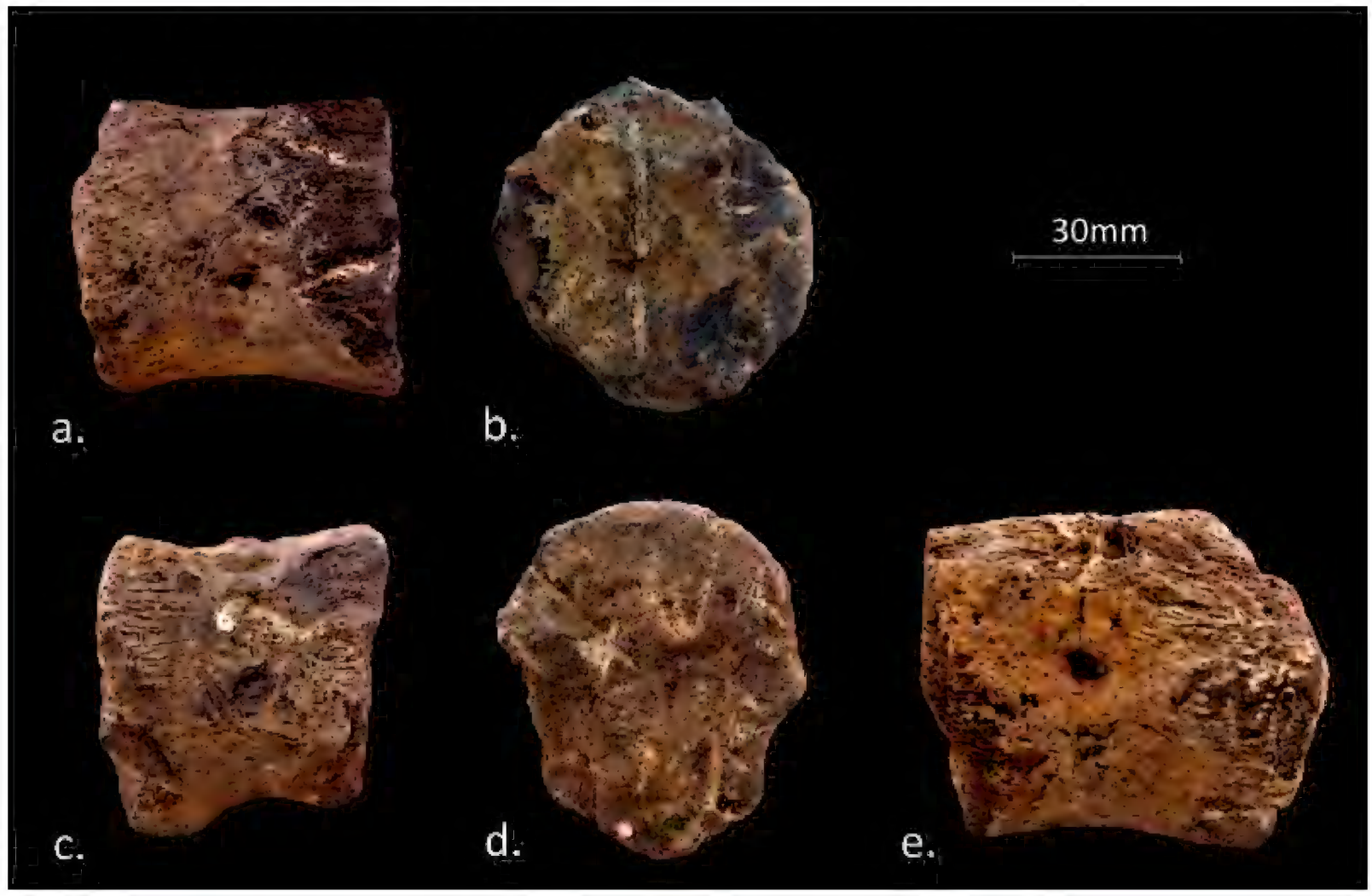

Figure 1. (a). SMNH P4036, lateral view; (b). SMNH P4036, anterior or posterior view*; (c). SMNH P4037, right lateral view; (d). SMNH P4037, posterior view; (e). SMNH P4037, ventral view showing subcentral foramen. Scale bar is approximate.

* As is sometimes the case with dorsal vertebral centra, it has not been possible to differentiate between the articular surfaces of this specimen.

The Lower Jurassic rocks form an escarpment near North Cliffe in the East Riding of Yorkshire and deposits of the same age as those found in the Scunthorpe district were exposed in marl pits near Hotham cross-roads (SE884342 and SE885339) in 1872. However, they were falling into disuse in 1958 (de Boer *et. al.*, 1958) and a search by A.J.P. and the author in the 1980s failed to discover any visible remains. These rocks do not extend far to the north of Hotham before being overstepped by an unconformity of Cretaceous rocks near Market Weighton (Page, 2004a, p. 215). Further to the north, strata of equivalent age to the Frodingham Ironstone

Member occur as the Calcareous Shales Member and Siliceous Shales Member of the Redcar Mudstone Formation and are exposed in the magnificent coastal sections of the Robin Hood's Bay area. Indeed, the Normanby Stye Batts – Miller's Nab (Robin Hood's Bay) Geological Conservation Review site provides the most complete Sinemurian and Pliensbachian sequence in Britain (see Page, 2004c, p. 262).

Details of the specimens

Unfortunately, plesiosaurs cannot be identified to genus and species level from isolated vertebral centra. This is due to the fact that the taxonomy of this group of predatory reptiles is mainly based on features of the skull, the vertebral count and the pattern of the shoulder and hip girdle bones. However, vertebrae can be identified to the region of the vertebral column from which they originated by the position of the rib articulations on the sides of the vertebral centra. Caudal vertebral centra bear facets for articulation with chevron bones (Milner and Walsh, 2010, p. 382). The centra display openings known as subcentral or nutrient foramina: these features enabled nerves or blood vessels to pass through to the neural canal (A. S. Smith, pers. comm., 2020). These foramina are characteristic of all plesiosaurs and occur in pairs on the ventral surface of the centra: they are "close together in cervical and caudal vertebrae and widely separated in dorsal vertebrae, where they are visible in lateral view" (Milner and Walsh, 2010, p. 382).

It is thought that specimen SMNH P4036 (Figures 1(a) and (b), p61) is probably a dorsal or rear cervical vertebral centrum whereas specimen SMNH P4037 (Figures 1 (c) - (e)), which displays prominent facets for articulation with chevron bones, is a caudal centrum. A subcentral foramen from this specimen is shown in Figure 1 (e). The general size and proportions of the specimens suggest that they came from a long-necked plesiosaur (A. S. Smith, pers. comm., 2020). These predatory marine reptiles had small heads, a long neck and a short body and tail. Four large flippers enabled these active hunters to catch and feed upon a range of small-bodied prey such as fish and cephalopods (Massare, 1987, p129). It is evident from the variety of suitable prey items, mainly ammonites and belemnites, present in the Frodingham Ironstone environment that these reptiles could have found sufficient food in the area. However, it should be remembered that wave or current action, perhaps associated with storm events, could have transported the remains of this plesiosaur to the shoal area in which they were preserved.

Plesiosaurs or other marine reptiles were not included in the faunal list for the Frodingham Ironstone Member (described as the "Scunthorpe Ironstone") presented by Cross (1875, p123) which, given the interest in fossil reptiles for which the Victorian era is famous, suggests that they had not been discovered at that time. Also, Hallam (1963) made no reference to plesiosaur remains in his consideration of the palaeoecology of the deposit.

In addition, the detailed guide to the sedimentology and bivalve palaeoecology of the Frodingham Ironstone Member produced by Young, *et. al.* (1990) does not mention any vertebrate remains. However, plesiosaur fossils have been found in the Frodingham Ironstone Member: Knell's interesting and well-illustrated guide to the natural history of the deposit mentions that "Several vertebrae have been found..." (1988, p. 22). Indeed, two vertebral centra from a plesiosaur, found together with two ichthyosaur centra, in the Frodingham Ironstone at "Scunthorpe" are held at Scunthorpe Museum. These were collected at an unspecified date by A. C. Dalton, the first Honorary Curator of the Museum when it opened in 1909, and are now

listed as P3433C and D in its catalogue (R. Nicholson, pers. comm., 2021). P3433C is thought to be a dorsal vertebral centrum, possibly from the start of that region, whereas the incomplete nature of P3433D means that its location on the vertebral column cannot be established with certainty (H. F. Ketchum, pers. comm., 2021; A. S. Smith, pers. comm., 2021).

Fossil marine reptiles also occur in beds of equivalent age to the Scunthorpe Mudstone Formation on the Yorkshire coast. The Redcar Mudstone Formation has yielded "occasional vertebrates, including vertebrae and teeth of ichthyosaurs, plesiosaurs..." from the exposures at Redcar Rocks (Page, 2004b, p. 249).

The specimens described in this paper will be donated to Scunthorpe Museum of Natural History [now known as North Lincolnshire Museum](specimen numbers P4036 and P4037). This is a suitable repository as it holds an extensive collection of fossils from the Frodingham Ironstone Member of Lincolnshire and is close to the location in which these fossils were collected.

Acknowledgements

The author wishes to thank Professor P. M. Barrett (Natural History Museum, London), Dr M. Evans (British Antarctic Survey, Cambridge), Dr H. F. Ketchum (Oxford University Museum of Natural History) and Dr A. S. Smith (Nottingham Natural History Museum) for their interest, guidance and advice. Special thanks are due to Dr A. S. Smith for commenting on a draft version of this paper. Ms R. Nicholson (Heritage Manager, North Lincolnshire Museum) kindly provided the specimen numbers for these finds and also supplied details of other plesiosaur remains in the Scunthorpe Collections. Ms R. Lucas (Collections Officer, North Lincolnshire Museum) is thanked for providing photographs of the specimens collected by A. C. Dalton.

This paper is dedicated to the memories of Mr A. J. Phipps (1931 – 2001) and Mrs P. I. Phipps (1934 – 2021).

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Errata

In Sam Buckton and Jane Thomas' article, 'The St Nicks Slug Crib' (Volume 146 Number 1108, 182-195), the authors wish to apologise for an erroneous label in the collage for Brown Soil Slug *Arion distinctus,* 'Central row of tubercles gives the impression of a keel'. This is a feature only of the false-keeled slugs Rusty False-keeled Slug *A. fasciatus* and Spotted/Silver False-keeled Slug *A. circumscriptus* agg.; the label was copied onto the Brown Soil Slug collage in error. We wish to point readers towards JT's Flickr pages, where she has uploaded digital versions of all the collages that can be viewed full size:
https://www.flickr.com/photos/97800889@N07/sets/72177720296659705/.

In addition, the article stated that JT's record of White Snail Mite *Riccardoella limacum* was the first confirmed English record of this species; further research by the authors has since revealed that Graham (1994) made accurate records of *R. limacum* from an unspecified location in Devon. JT's record is nonetheless the first for Yorkshire, as far as we are aware, and we remain on the lookout for *R. reaumuri* and *R. canadensi* (see Fain & van Goethem, 1986).

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In the report of the 2021 Askham Bog excursion (Volume 146 Number 1108, 226-235), the photo of *Contarinia solani* galls (p.228) was erroneously attributed to Tom Higginbottom; the photo is Sam Buckton's. Sam's record was the first of this midge for Yorkshire, a notable fact not mentioned in the text.

The History of the Wild Daffodil in Huddersfield

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"Daffodils that comes before the Swallow dares and take The winds of March with beauty".
A Winter'sTale *W. Shakespeare*

"Fair daffodils we weep to see you haste away so soon"
Robert Herrick (1591-1674)

Introduction

Known since the 1600s, the Wild Daffodil or Daffydowndilly is an English native plant which was once widespread and common in damp woodland and grassland. John Gerard, in the late 16th century, spoke of it as 'growing almost everywhere through England' and 'so well knowne to all, that it needeth no description'. However, since the middle of the 19th century, except in certain areas, it has become increasingly rare.

Lent Lily, Easter Lily and Easter Rose are just a few of the common names given to *Narcissus pseudonarcissus*, the Wild Daffodil, which belongs in the Liliaceae family. It is a bulbous perennial plant with greyish-green leaves borne on a short to medium stem roughly 6-9 inches high. Flowering in spring, the solitary bloom has pale yellow tepals and a large, yellow trumpet-shaped corona (see Front Cover).

History

1724. John Ray recorded it as growing at Coley Hall near Halifax (Lavin & Wilmore, 1994).
1859. Charles Hobkirk wrote the first extensive survey of the flora and fauna of Huddersfield and he records the Daffodil (Hobkirk, 1859) but, as far as is known, no locality is given. However, Hobkirk's revised edition (Hobkirk, 1868) recorded it in a new locality – Woodsome and Storthes Hall Wood.
1888. No date is given by F.A. Lees (1888) but he also gives Woodsome and Storthes Hall Wood, presumably the same site as that recorded by but not named in Hobkirk.
1889. A new locality near the waterfall in Storths Hall Wood (note the spelling) was recorded by Alan Godward (sometimes written as Allen Godward). As far as is known, this is an unpublished record.
1893. A herbarium sheet in Tolson Memorial Museum dated 15 April by Thomas William Woodhead gives the site as Storthes Hall Wood. There are no further records from this site.
1972. Daffodils were found by Stephanie Coghlan in a field in Almondbury in 1972. The field was

uncultivated and had been used for occasional grazing for horses. They have flowered every year to date despite ploughing in 2015. Prior to the publication in 1994 of the *West Yorkshire Plant Atlas* the botanical recorders at that time were told of the plant's discovery, but the record was not published and was rejected on the grounds that "it does not grow in this area" (J. Coghlan, pers. comm.) The Atlas authors did record an undated personal communication from G. Barker reporting the plant as native (possibly) at one site in Calderdale.

Present Day

Stephanie and I met on 6 April 2015 when she invited me to see the plants and confirm their identity. I was very happy to do so though I had no doubts as to their identification as Stephanie was a far more competent botanist than me. Then later in that year the field was ploughed and seeded with a grass crop for hay. This was potentially dangerous for the Daffodils. On 10 January 2016 the ploughed field was seen and photographed in a water-logged state but when the field was visited on 23 April 2016, the Daffodils were thriving in the ploughed furrows. However, due to the uncertainty of the field's future use and because the species is so rare, it was decided to send in the record again and this culminated in Geoffrey Wilmore (YNU VC63 botanical recorder 1993-2015) coming to Huddersfield in 2017 to confirm the plant's identity. It was decided that a rescue operation was necessary, so with the farmer's consent, a number of bulbs were removed by myself and Michael Brook on 26 April 2018 and potted up to over-winter before transplanting them to new sites.

The bulbs were transplanted on 3 July 2019. Upper Park Wood, a Local Nature Reserve, was chosen as a suitable habitat and small clumps were planted in a number of places by me and Jim Coghlan. More bulbs were removed on 2 April 2019.

Due to the Coronavirus lock-down in 2020 it was not until March or April 2021 that a visit was made to Upper Park Wood by J. Coghlan to check on the welfare of the Daffodils. Happily they were flowering and becoming established. The original site was visited on 15 April 2021, again by J. Coghlan, who reported that the Daffodils were still growing in the field where they were first recorded. Some bulbs were planted on Snow Island which is designated as "open space" and the Greenstream Project led by Environment Kirklees Ltd. is developing it into a public amenity park. The bulbs here are thriving and flowered in 2021.

I have in my possession a little black book measuring 3½" x 2" (now donated to the Tolson Museum). There is no clue as to who owned the book or who compiled the contents. It comprises lists of plants and where and who recorded and identified them. Alan Godward is one name that often appears (Figure 1, p67). Hobkirk and Lees were botanists and along with other local botanists published lists of plants recorded from the Huddersfield area in the publications of the various naturalists' societies to which they belonged.

Surprisingly, Alan Godward is not well known but, like his father G.G. Godward, he was a botanist and his name occurs quite frequently in publications of the day as the identifier of plants. It is recorded that on 11 May 1872 and on 9 May 1874 at the Huddersfield Naturalist Society (founded in 1850) he named plants. In 1875 on 3 April he brought 'botanical specimens' and he recorded *Draba verna* on 31 March 1877. The Huddersfield Naturalist Society held its 6th Grand Exhibition at Victoria Hall on 4 September 1880 where he exhibited grasses and ferns.

Victoria Temperance Hall, to give it its proper name, was built in 1879 on Buxton Road but is no longer in existence. It is recorded that one hundred plants from Wales brought by E. Fisher were named by Alan Godward at a meeting of the Huddersfield Naturalist Society on 15 July 1882 and on 29 September 1883 he again named plants. An unusually large collection of plants from the Pontefract/Askern area in 1884 was shown by Godward, Shaw and Beaumont at Victoria Hall.

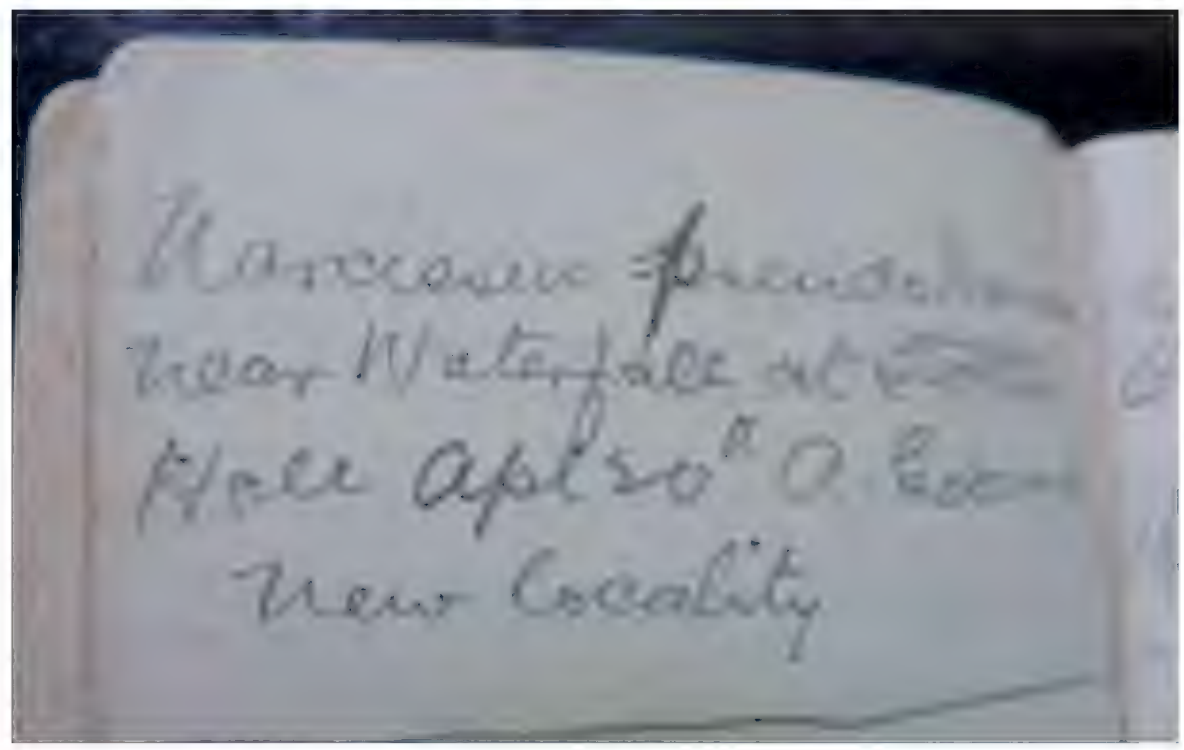

Figure 1 Notebook page with hand-written record of *Narcissus pseudonarcissus* attributed to A. Godward.

On page 124 of the Proceedings of Provincial Scientific Societies is a record of Frog Orchid *Habenaria viridis* (now *Coeloglossum viride*) found in 1860 by G.G. Godward. This is followed by Alan Godward refinding the plant in the same situation 1898. Alan Godward's herbarium was donated to what was then the Biological Department of the Huddersfield Technical College. W.E.L. Wattam in 'Old Plant Records of the Huddersfield District' writes "... contains several plants of which no previous record for the Huddersfield district seem to be in existence, as well as confirmatory records of many which formerly existed, but are now extinct in that district." The herbarium is now housed in the Tolson Memorial Museum. It would put the finishing touch to this saga if some one fitter than this 88 year old could, in the future, visit the waterfall at Storthes Hall Wood and rediscover Huddersfield's own Daffydowndilly.

Acknowledgements

With very grateful thanks to Alan Brooke for sharing his knowledge of, and providing information on, Alan Godward. I am indebted to Jim Coghlan for allowing me to use his and Stephanie's photographs and for checking and correcting relevant parts of the text. Many thanks also to: Dave Pattern for searching Charles Hobkirk's first record of the plant in the 1859 volume; Miriam Shorter for proof reading and suggesting alterations to the text; and to Nathan Smith, Curator, Tolson Museum, for making it possible for me to examine the appropriate herbarium sheet.

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Leaf-mining flies (Agromyzidae) new to the Yorkshire Diptera list : Part 4

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Introduction

Following Warrington (2017, 2018, 2019, 2021(a)), five species of Agromyzidae are hereby added to the Yorkshire Diptera list. Three additions are based on collected or reared adult material with two species being added owing to their characteristic larval mine. All observations are those of the author unless otherwise stated.

Additions

Agromyza audcenti Gibbs, 2004

Tim Hodge collected at Raincliffe Wood, North Yorkshire (VC62) 13 September 2020, with specimens sent to me for determination. Within the sample was a single male *A. audcenti*, the first record of this species in Great Britain since it was described in 2004. Its host plant remains unknown.

Agromyza flaviceps Fallen, 1823

Sam Buckton recorded a larval mine (Figure 1a, p69) of this species, on 22 September, from St Nicholas Fields (York, VC62) on a single vegetative plant of Hop *Humulus lupulus* along what is colloquially referred to as 'Rosebay Ridge' following the line of Tang Hall Beck (SE61495191). It grows just beside the path at the edge of the woodland running down the steep bank to the beck, beginning to twine itself around the nearby birches.

Agromyza marionae Griffiths, 1963

In July 2020, inconspicuous external stem mines on *Vicia* were discovered in Hessle, East Yorkshire (VC61). Several stems were collected, with 2 males and 2 females being successfully reared (adults emerging the following spring), with one male dissected to confirm the causer. A very rare species, this record represents the first known occurrence in almost 40 years.

Aulagromyza populi (Kaltenbach, 1864)

The distinctive leaf mines (Figure 1b) of this species were found on Black Poplar in north Hull, East Yorkshire (VC61). This record represents the most northerly known population in Great Britain.

Napomyza crepidicaulis Warrington, 2021

A species new to science, discovered in 2020 from a newly-created flood alleviation site in Anlaby, East Yorkshire (VC61). Adults were reared from puparia obtained in the stems of *Crepis capillaris* (Warrington, 2021b).

Acknowledgements
Thanks to Sam Buckton for providing collection details and image of *Agromyza flaviceps* and Tim Hodge for allowing me to retain the *Agromyza audcenti* specimen.

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Left: Figure 1a. Larval mine of *Agromyza flaviceps* on Hop. *Photo:* Sam Buckton).
Right: Figure 1b. Mine of *Aulagromyza populi* on Poplar. *Photo:* Barry Warrington.

YNU Excursions 2022

Circular No. 920

Divisional Secretary VC65: Terry Whitaker
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VC65 excursion to Jervaulx Abbey & Jervaulx Park on **Saturday 21 May at 10:30am**.

Meeting place. Car park (£1), off the A6108 at SE16888570. (Post-code to use is HG4 4PH)

The Lepidoptera group is invited to trap in the area on 20 May (Friday night). Meet at SE16888570; no electricity supplies are available.

Reporting Meeting. To be arranged

Maps: OS Map Landranger Map 99 Northallerton & Ripon.
OS Explorer Map OL2 Yorkshire Dales, Southern & Western Areas, 1:25,000.
Geological Survey of England and Wales 1:63,360/1:50,000 geological map series, New Series Masham Sheet 51 (Solid Geology).

The area is underlain by the Upper Carboniferous (Arnsbergian E2). The Red Scar Grit (a coarse-grained feldspathic sandstone) out-crops low down on the valley sides and across the valley about 1km downstream. Not far upstream towards Jervaulx Hall and West Witton the Crow limestone outcrops (Pendelian, E1) but at Jervaulx all the limestones of the Upper Carboniferous are absent and the Cockhill Marine Band (with specimens of the goniatite *Cravenoceras cowlingense*) which marks the boundary of the E1 & E2 facies, runs north-south across the site. The predominant nearby surface beds at Jervaulx Park are mudstones but they are mainly obscured by river gravels or glacial drift.

The River Ure is a wide, gently meandering river occupying a very broad, open 'U'-shaped glacial valley, overlying the Great Scar limestone and with valley sides down to Middleham with a distinctively stepped profile formed by the stepped scars of the Yoredale series. In the area of Jervaulx and the lowest reaches of Wensleydale the valley side profile is more gently sloping and the valley floor is rather flat and mostly less than 100m ASL. In its lower reaches has only a single significant tributary, the River Cover, which joins 2km higher up the valley from Jervaulx, near Middleham and the easternmost point of the Yorkshire Dales National Park.

Woodland is scarce in the area consisting mainly of small plantations, often mainly coniferous, and tiny copses, generally concentrated on middle valley side slopes. Jervaulx Estate gives a strong parkland character to eastern end of the dale with mature roadside oak trees and hedgerow trees a feature of this area.

Field pattern consists of mainly rectangular enclosures most of which have been greatly enlarged by boundary removal during the past seventy years. More than half of the valley floor land, especially north of the river, is plough land. The valley grassland is mainly improved.

Jervaulx Abbey Park is a landscaped park with an associated country house. It is centred on a 12th century Cistercian Abbey ruin, the largest privately owned and maintained Cistercian abbey in the UK, owned by the Burdon family. Initially much of Wensleydale was in the control of the Cistercian monks. Jervaulx became wealthy, owning much of the land on the north side of the river above Askrigg known now as Abbotside. Outlying working farms or 'granges' such as those at Braithwaite and Grange were established to manage the huge estate of Jervaulx Abbey. The main wealth was provided by wool from sheep, which eventually led to overgrazing and loss of wooded areas. Most of the estate is within the northern two thirds of 1km square SE1785.

One of the many pleasing aspects of a visit to Jervaulx is to view the wild flowers, both native and introduced, adorning the ruined walls. They include Wild Lettuce *Lactua virosa*, Hairy Rock-cress *Arabis hirsuta* agg. and Fine-leaved Sandwort *Minuartia hybrida*. The area has a fairly long botanical list with over 200 species of flowering plants and trees recorded. Over the last few years much of the grassland within the Park has been managed to increase biodiversity by controlled cutting and grazing.

On the stonework of the Abbey are many lichens. *Opegrapha calcarea* is one of the more common finds. This is a rather nondescript, grey, round lichen with small black streaks. *Caloplaca flavescens*, found on one of the limestone pillars of the old chapter house, is a yellow rounded lichen; crustose with lobed margins, but much less common than the yellow lichens usually found in this area and

rare further north. Like *Caloplaca aurantia* it is common on hard calcareous rocks, walls, headstones and memorials but very more common on the chalk lands of southern England.

The River Ure forms the northern boundary of the estate but unfortunately much of the river channel has been highly constrained with hard embankments and flood bunds. This has resulted in much lowered diversity of riparian habitats. In the grounds are two fishing lakes whose limnological flora and fauna appear to be woefully unrecorded although Smooth & Great Crested Newt and Common Toad have been noted. Likewise for Lepidoptera; the main 1km grid square has only three species of moths and the total for all three 1km grid squares within the site have only four species: Ruby Tiger, Mullein and Copper Underwing with *Agriphila tristella* as the only micromoth.

Previous YNU visits to the area

There have only been two previous YNU excursion to the site. The first in 1898 and the most recent in 1969.

References

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Circular No. 921

Divisional secretary VC61: Dr Africa Gómez; Dept. of Biological and Marine Sciences, University of Hull, Cottingham Rd, Hull HU6 7RX.

Tel: 07871144192; Email: a.gomez@hull.ac.uk

The VC61 excursion will be held at Leven Canal on Saturday 25 June 2022

Meeting Place: Meet at the junction of Sandholme Lane and Carr Lane (TA101450) at 10:30 am. (what3words ///depend.quicksand.below)

Maps: OS Explorer 295 1:25000 Bridlington, Driffield & Hornsea; OS Landranger 107 1:50000 Kingston upon Hull, Beverley and Driffield. Although the focus is Leven Canal, we have obtained permission to explore Leven Carrs, on the western end of the canal

Reporting meeting: Leven Sports Hall (TA106455) at 4:30 pm.

There are a few B&Bs in the village, many more at nearby Beverley and Hornsea. There are no public facilities or electricity at the site.

History: The Leven Canal is a disused canal that runs from the south end of the village of Leven to the River Hull, between Eske and Leven Carrs, a length of 5km. It was cut in 1802 across 2 existing meres and marshland, which were later drained, and opened to navigation in 1805. The canal is in one level and a single broad-gauge lock with a set of three gates allowed keels to enter and leave from the river Hull when level or high tide. A basin almost reached the road in the village, but is now mostly infilled and not publicly accessible. Navigation was closed in 1935 due to limited traffic with the development of rail and improved roads.

The area suffers from seasonal flooding, which has been encouraged more recently in Leven and Eske Carrs. A low-lying area of 130ha in Leven and Eske Carrs, from Waterloo Bridge to the River Hull, lower than 5m OSL, and below sea level in some areas, is managed under a stewardship scheme to enhance its biodiversity value and includes scrapes and lagoons. Management has included restoration of wet grassland by grazing with Belted Galloway cattle; creation of scrapes that hold seasonal and permanent wetlands and hydrologically isolating the wetlands from surrounding agricultural land. This land is likely to have been traditionally managed as wet grazed grassland.

Geography: The area forms part of the River Hull valley and is characterised by large fields bounded by drainage ditches. As typical of Holderness, the surrounding land is flat and low-lying, formed by alluvium covering glacial boulder clay with some sand and gravel on the higher land near and on the village. Sheppard (1957) identified the existence of several meres in medieval times, now disappeared, in the area. The canal itself is, at least partly, fed by very high quality water from calcareous springs and runs higher than the surrounding landscape, so does not suffer from agricultural run-off. Today, the canal is not connected to the River Hull, and it is separated from it by the river flood bank, although the water level is maintained by allowing inflow of water from the River Hull via a sluice. After some slight bends near the village, the canal runs almost perfectly straight along an east-west line, flowing westwards. The eastern half of the canal is mostly placed on agricultural land with some small copses and plantations.

The canal towpath alongside the whole of its North bank is a public footpath. There are three bridges, one of them pedestrian: one crossing over the aqueduct (Far Fox), Sandholme in the village and Waterloo Bridge. Both the canal and surrounding land are privately owned. The canal crosses Holderness drain via a raised pipe taking canal water (it used to be an aqueduct), and Burshill and Barff Drain via Sandholme viaduct. The footpath by the canal joins the footpath on the east bank of the River Hull, which can be used to walk back via a circular walk or to visit Pulfin Bog SSSI and High Eske, which lay about 1km south. Note that there are no accessible bridges over the river Hull nearby, but a circular walk back to Leven can be carried out by walking north to Baswick Steer on the river bank, then back via Low Baswick Farm.

Flora: The aquatic plant communities of Leven Canal have botanical conservation value of national importance and the whole of the canal is now a SSSI, first notified in 1962 and revised in 1986. The clear, calcareous water of the Leven Canal holds abundant submerged and marginal vegetation with a species-rich flora, including some regionally scarce species (Middleton and Cook, 2014), indicating a good maintenance regime. The canal was botanised by the renowned botanist Eva Crackles (Crackles, 1968, 1977), who wrote the botanical section on the 1952 YNU Excursion report. More recent aquatic vegetation surveys by Goulder (2006, 2017) noted abundant yellow *Nuphar lutea* and white water-lilies *Nymphaea alba*, and submerged plants like Rigid Hornwort *Ceratophyllum demersum*, Mare's-tail *Hippuris vulgaris*, Shining Pondweed *Potamogeton lucens*, Arrowhead *Sagittaria sagittifolia* and Greater Bladderwort *Utricularia vulgaris*.

Fauna: Notable birds include Hobby, diverse warblers including Grasshopper Warbler, Cetti's Warbler, Sedge Warbler. Yellowhammer, Cuckoo, various waders. The canal also holds an abundant and diverse odonata assemblage (15 species recorded), with Hairy Dragonfly *Brachytron pratense* a notable species.

Previous YNU visits to the area: The last and only YNU excursion, circular 526, took place on 26th July 1952, 70 years ago.

References

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Circular No. 922

Divisional Secretary VC62: Sarah White, Yonder Cottage, Ashford Hill, Thatcham,Berkshire, RG19 8AX. Tel: 07775 853478; Email: white.priests@gmail.com

The VC62 Excursion will be held at Strensall Common Military Training Area on Saturday 9 July 2022.

Maps:
OS Landranger 1:50000 York & Selby 105; Malton & Pickering 100.
OS Explorer 1:25000 York 290; Howardian Hills & Malton 300
MOD maps of waymarked paths will be distributed at the meeting.

Meeting Place: Meet at 10.30 am at the Galtres car park (SE648611), nearest postcode YO32 5YB. From A1237 York northern bypass take Strensall Road north towards Strensall and Flaxton. After passing the Six Bells pub on the left-hand side, continue for another 1.5 miles, past the golf course, and the car park is on the right immediately after the cattle grid. This is a busy car park, particularly at weekends, but the MOD is kindly opening the barrier to allow us to access additional parking beyond the public car park.

Tea and Meeting: 4pm at Strensall Village Hall (SE635610), YO32 5XW. From the Galtres Car Park, drive south over the cattle grid and after 0.6 mile take the first right turn into Strensall village. After the level crossing, follow the road round to the left and the hall (red roof) is on the right behind the play area. There will be a modest charge for tea and the use of the room.

The Area: Strensall is one of two important large remnants of lowland heathland in the Vale of York (the other being Skipwith Common). It is notified as a SSSI and a SAC. Originally common land, 1600 acres was acquired by MOD in 1884 for military training and live firing marksmanship training, at which time the common rights ceased. MOD regards wildlife conservation as an important management priority, second only to military use, and its ownership of the site has almost certainly ensured its protection and survival as an important wildlife site. An area of 42ha in the northwest is managed as a YWT reserve and another 42ha block to the east of the MTA, called 'World's End', is partly managed by the Forestry Commission.

The site overlies glacial deposits of sands and clays which, together with wind-blown sand, support a range of habitats including wet and dry heathland, acid grassland, woodland and a number of ponds.

The dry heath habitat supports Heather *Calluna vulgaris* and extensive areas of Bracken *Pteridium aquilinum*. Petty Whin *Genista anglica* occurs here and birches, oaks and Scots Pine *Pinus* sylvestris form scattered areas of woodland. Where the ground is wetter, Purple Moor-grass *Molinia caerulea* forms extensive stands together with Cross-leaved Heath *Erica tetralix* and this wetter component supports a population of Marsh Gentian *Gentiana pneumonanthe.*

There is a large number of ponds of considerable wildlife importance and Strensall has been identified as a Flagship Pond site by the Freshwater Habitats Trust. The oldest ponds probably originated as peat cuttings and clay pits while more recently ponds have been excavated for conservation purposes. Kidney Pond, located in the centre of the site and within the restricted military area, retains some open water but much of it has vegetated over with Bottle Sedge *Carex rostrata* and *Sphagnum* mosses. Components of this community include Greater Bladderwort *Utricularia vulgaris*, Slender Sedge *Carex lasiocarpa*, Marsh Cinquefoil *Comarum palustre*, Bogbean *Menyanthes trifoliata*, Tubular Water-dropwort *Oenanthe fistulosa* and Marsh Stitchwort *Stellaria palustris*. Nearby is a scrape excavated in 2012 in which Pillwort *Pilularia globulifera* appeared and was recorded again in 2016. Lesser Water-plantain *Baldellia ranunculoides* also occurs here. A third pond, 'Crossley's Pond' appears to be a natural depression and has an almost complete vegetation cover while remaining permanently wet. Again, it is dominated by Bottle Sedge, Common Sedge *Carex nigra* and *Sphagnum* with Bogbean, Creeping Willow *Salix repens* and Marsh Cinquefoil. A survey of these three ponds in 2016 yielded 117 macro-invertebrates of which most were water beetles and water bugs. A number of species of conservation concern were found including the Mud Snail *Omphiscola glabra*, several nationally scarce water and diving beetles and the moss beetle *Limnebius aluta,* for which Strensall might be its only remaining site in Northern England. The nationally scarce caddis fly *Trichostegia minor* has also been recorded and there is a rich assemblage of Odonata including eleven dragonflies and eight damselflies.

The area known as World's End comprises woodland, wet grassland, heathland and a number of ponds which were excavated as part of the heathland restoration following the felling of Corsican Pine between 2003 and 2005. Both Red-eyed Damselfly and Small Red-eyed Damselfly breed here, one of the most northerly breeding sites for these species.

A transect through the eastern end of the Common and World's End has been walked since 2017 for the UK Butterfly Monitoring Scheme and the 25 species, several of conservation concern, highlight the importance of the area for butterflies.

Over 600 species of moths have so far been recorded at Strensall, including a considerable number of interesting species characteristic of lowland heaths such as Small Chocolate-tip, Northern Drab and Silver Hook. The site is most important as the only English site for the Dark-bordered Beauty *Epione vespertaria*, a day-flying moth which feeds on Creeping Willow. This is monitored annually and grazing exclosures protect the foodplant. There will be an opportunity to go and look for the Dark-bordered Beauty before the meeting starts, around 9 am. A moth trapping session is also planned for the evening before the excursion and those arriving early will have a chance to see the traps emptied. Please let me know in advance if you would like to bring a light trap and take part in the Friday evening moth trapping.

The site supports a wide range of Diptera including the rare muscid *Phaonia jaroschewskii,* which was found at Strensall in 2018, confirming a first report in the same area of the Common in 1996. It is associated with *Sphagnum*-rich habitats and important as an indicator of the health of these habitats, as it will disappear if the bog deteriorates. Hence it was immortalised as the 'Hairy Canary' by Peter Skidmore in the conservation battle over Thorne and Hatfield Moors, the allusion being to

the practice in the coal mining industry of having canaries in the pits to give early warning of gas.) The rare cranefly *Idioptera linnei* also occurs in three widely scattered localities on the Common.

Historically, Strensall has also been an important site for the rare Tormentil Mining Bee *Andrena tarsata* as well as its nest parasite *Nomada roberjeotiana*. These have not been recorded at Strensall since 2008 and 2009 respectively and are the subject of a Recovery Project through the Species Recovery Trust. The habitat remains very suitable, and it is hoped that the Excursion might provide an opportunity to re-find them. Members will also be asked to identify areas of the Common which might be particularly suitable for pollinators generally as part of the City of York's Pollinator Strategy, and to make management recommendations.

Annual bird surveys are carried out on the Common and a good range of species is recorded including Cuckoo, Nightjar, Linnet, Tree Pipit, Skylark, Reed Bunting and Woodlark. Curlew continues to breed here but numbers have declined and only a single territory was recorded in 2021. Reptiles and amphibians are well represented with Great Crested, Smooth and Palmate Newts, Common Lizard, Adder, Common Frog and Common Toad.

The day of our visit will be a non-firing day so we will have access to the restricted military area including Kidney Pond, as well as the YWT reserve and the Forestry Commission land at World's End.

Remarkably, the last YNU Excursion here was as long ago as 9 July 1949. The only other Excursion was on 14 July 1883 when Dark-bordered Beauty was described as 'well out and in beautiful condition'. Amongst the notable plants mentioned in the earlier excursion accounts which have not been recorded here for some time are Marsh Clubmoss *Lycopodiella inundata*, Meadow Thistle *Cirsium dissectum*, Lesser Marshwort *Helosciadium inundatum*, Saw-wort *Serratula tinctoria* and Dioecious Sedge *Carex dioica*.

During 2018 the Yorkshire Fern Group and the Freshwater Habitats Trust undertook the translocation of Pillwort from the Pillwort Pond to other ponds on the training area which had characteristics suitable for colonisation. Our meeting provides an opportunity to check on the current distribution of Pillwort and to help monitor the success of the translocation.

References:

Buglife Species Management sheet for Tormentil Mining Bee
https://cdn.buglife.org.uk/2019/07/Tormentil_0.pdf

Crossley, R. (2007) Diptera of Strensall Common, Sanctuary Magazine 36: 22.

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Reed, P. (2010) Bird Surveying at Strensall Common, Sanctuary Magazine 39: 22

Species Recovery Trust https://www.speciesrecoverytrust.org.uk/the-tormentil-mining-bee

Williamson, B & Owen, M. (2014) Strensall Flagship Ponds. Sanctuary Magazine 43: 50.

Circular No. 923

Divisional Secretary VC63: Joyce Simmons, 16 Springfield Crescent , Kirk Smeaton, Pontefract, W. Yorks WF8 3LE

Tel: 01977 620725; email:Joyce@gentian.plus.com

The VC63 excursion will be to the Brockadale YWT Nature Reserve on Saturday 23 July 2022.

Maps:
OS Landranger 111 1:50000 Doncaster
OS Explorer 279 1: 25000 Doncaster

Meeting Place: Meet at 10.30 am in Brockadale car park (SE514174). For mobile phone location, put in 'Leys Lane Little Smeaton'. There are no toilet facilities here, the nearest are at the Ferrybridge service station at the junction of the A1 and M62.

Reporting Meeting: In Kirk Smeaton Church at 4 pm. The church has a kitchen and toilet and will be open from 3.30. Tea and coffee will be provided. There is parking near the church and along the village street.

The area: Brockadale has been a YWT reserve since 1966, although naturalists have recorded in the valley since Victorian times. There have been several YNU excursions here including in 1864, which involved walking the 7 miles from Pontefract station and back! More has been added to the reserve as YWT has purchased land when available, so it now extends to over 60ha. Much of the reserve is designated as SSSI. The River Went, a tributary of the Don, cuts through the ridge of magnesian limestone which stretches from Nottingham to Durham. The valley through which the Went now flows was created when glacial melt water broke through the ridge, resulting in the valley's steep, craggy slopes. The soil cover is of various thickness, from very shallow or exposed rock to deep alluvial soils on the valley floor. The riverside includes willow carr, mixed plantation and scrubby meadows. Steep-sided and gently sloping meadows and woodlands line both south- and north-facing slopes.

The reserve is renowned for its extensive range of limestone plants, some of which are otherwise rare in Yorkshire. Where possible, management of meadows involves mowing and hay removal by local farmers, but steep slopes are grazed by cows in winter followed by manual removal of unpalatable scrub. In mid-July the floral displays of Clustered Bellflower *Campanula glomerata*, Scabious spp. and *Hypericum* spp. among others, are spectacular. The southerly aspect of some slopes allows the survival of taxa which are otherwise only found much further south, such as the Purseweb Spider *Atypus affinis* and the tiny and very rare Cylindrical Whorled Snail *Truncatellina cylindrica*. The woodlands on higher ground are varied, with a Beech wood planted in 1890, mature specimens of native trees, coppiced old Hazel *Corylus avellana* and many recent native plantings. Butterflies of 25 species, including Dark-green *Argynnis aglaja* and Silver-washed Fritillaries *Argynnis paphia* breed here. Moth-trapping has so far recorded 479 species including Pretty Chalk Carpet *Melanthia procellata* at its sole site in Yorkshire. Local expertise in other invertebrate groups is limited, though new taxa are still being found, such as the rare Horned Dor Beetle *Odonteus armiger* and Ornate-tailed Digger Wasp *Cerceris rybyensis,* but new records from this visit would be very much appreciated. The reserve is about to have a quarry extended very close beside it on the south side and any notable records

will be extremely valuable, especially if particular habitat conditions need to be protected or enhanced.

Circular No. 924

Divisional Secretary VC64: Ken White, Yonder Cottage, Ashford Hill, Thatcham, Berkshire, RG19 8AX.

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The VC64 Meeting will be held at Humberstone Bank Farm on Sunday 14 August 2022.

Maps:
OS Landranger 1:50000 99 Northallerton & Ripon; 104 Leeds & Bradford.
OS Explorer 1:25000 298 Nidderdale.

Meeting Place: Meet at 10.30 am at Humberstone Bank Farm (SE132607), nearest postcode HG3 4AX. The farm is located on the west side of the road between Blubberhouses and Greenhow. There is a sign where the farm track leaves the road. There are toilet facilities at the farm in a converted barn called the 'Humberstone Hub'.

Tea and Meeting: 4 pm in the 'Humberstone Hub' at the farm. There will be a modest charge for tea.

The Area: Humberstone Bank Farm, at the head of the Washburn Valley, is a large upland farm with 904 hectares of moors and grazing land farmed by Jonathan Grayshon who took over the tenancy in 2016. It is farmed under a Higher Level Stewardship agreement and grazed by Swaledale sheep and Belted Galloway cattle.

Owned by Yorkshire Water, Humberstone Bank was the first farm to be signed up to its 'Beyond Nature' tenancy. Yorkshire Water recognises that the land is not just important for capturing water and the 'Beyond Nature' initiative supports its farm tenants to optimise the value of other important land uses such as providing a home for wildlife, storing carbon, offering opportunities for recreation, farming livestock and delivering natural flood-management. As one of the largest landowners in Yorkshire, it aims to have a positive and lasting impact on the environment.

This Excursion will support the 'Beyond Nature' initiative by recording wildlife on parts of the farm which comprise open moorland, enclosed semi-improved pastures and shelterbelts. The River Washburn runs in a steep-sided valley between the moorland and the inbye land, giving rise to some waterlogged and marshy ground in the valley bottom.

The open moorland grazing land lies within West Nidderdale, Barden and Blubber-houses Moors SSSI, one of a series of moorland SSSIs in the North Pennines which are of international importance for their blanket bog and heather moorland vegetation communities. These moorlands have a nationally important assemblage of moorland breeding birds including Merlin, Golden Plover, Snipe, Curlew, Redshank, Teal and Short-eared Owl.

Dry heath dominated by Heather and Wavy Hair-grass *Deschampsia flexuosa* covers most of the site. Bilberry *Vaccinium myrtillus* becomes more abundant on steeper slopes, particularly in gills, with Cowberry *Vaccinium vitis-idaea* more frequent on higher land. Areas of blanket

mire occur on the higher moorland where deep peat has accumulated. Hare's-tail Cotton-grass *Eriophorum vaginatum* is dominant, with Cross-leaved Heath, Crowberry *Empetrum nigrum*, Common Cotton-grass *E. angustifolium* and Heather. Cloudberry *Rubus chamaemorus* is locally abundant in places. In areas of wet heath or valley mire, the richest bog vegetation persists and supports Cranberry *Vaccinium oxycoccos*, Bog Asphodel *Narthecium ossifragum*, Cross-leaved Heath, *Sphagnum* bog mosses, Round-leaved Sundew *Drosera rotundifolia* and Bog Rosemary *Andromeda polifolia*. Chickweed Wintergreen *Lysimachia europaea* was recorded on the farm in June 2016 and 2018.

On the day of our visit there will be easy access to the in-bye land and shelterbelts around the farm buildings. The marshy grassland and headwaters of the River Washburn can be accessed via a short steep path and lifts in 4WD vehicles will be available. Another easy access point to the river and woodland habitats is on the minor road Hoodstorth Lane at SE133596.

The moorland areas lie beyond the river valley at some distance from the farm buildings but can be reached via a bridlepath which leaves the road at Red Gate (SE128594). This bridlepath is accessible by 4WD vehicles and lifts will be arranged. The Excursion takes place on a Sunday to avoid any shooting on the moor and the gamekeeper is aware of our visit.

References

Yorkshire Water website: https://www.yorkshirewater.com/environment/beyond-nature/humberstone-bank-farm/

Link for SSSI map and citation: https://designatedsites.naturalengland.org.uk/SiteDetail.aspx?SiteCode=S2000321

Book Review

The Peatlands of Britain and Ireland: A Travellers Guide by Clifton Bain (2021). Sandstone Press, PO Box 41, Muir of Ord, IV6 7YX. 255pp. ISBN: 978-1-912240-24-1. RRP £24.99.

Peatlands are one of the natural history wonders of the British Isles, richly entwined with our history and now widely seen as a key part of the future of carbon and water management in the landscape. In this lavishly illustrated book, with colour photographs throughout and illustrations from Darren Rees, Clifton Bain takes us on an engaging though necessarily brief, tour of the main peatland areas of Britain and Ireland.

The book, in hardcover format, is clearly intended as a coffee-table type book. It is an accessible read, avoiding too much scientific detail and references, instead including a selection of published sources and websites at the end of the book.

The author begins with a general introduction to his personal and professional association with peatlands, which illustrate his unique position to present this account. His passion for these sites is clearly deep-founded and it shines through in the subsequent accounts. There then follow further introductory sections, covering types of peatland, their wildlife, archaeology, the language of peatlands, past exploitation, conservation and the future for peatlands in general. Finally the introductory section provides an overview of the subsequent accounts with useful guidance on how to interpret the maps and use the travel advice.

Following these there are individual accounts of particular peatland areas. The geographic coverage is split into each of the separate countries that make up the British Isles, then further sub-divided by broad geographic region. There is an introductory double-page spread for each country, and the same again for each region. There follows one to four detailed accounts of the main peatland areas in each region.

The accounts of individual peatland areas include a map of the extent of peat soils and photographs that convey an impression of these areas. The text names and discusses some of the key individual peatland sites (many are nature reserves), giving an overview of their distinctive wildlife, naming important plants, birds and other species where they have a strong association with a particular site. It is refreshing, given the extensive exploitation and degradation of peatlands, that the book presents wide-ranging and varied initiatives to protect and restore these peatlands as their value as intact ecosystems becomes increasingly apparent. These initiatives are discussed in the individual site accounts, but also at the regional or national level where appropriate. The author has visited each of these sites, and this shows in the clear concise text that captures the essence of each of the regions discussed.

Each account includes a few paragraphs with details of how to access the main visitor points for each region, primarily using public transport (sometimes finishing on foot), and in many cases highlighting potential walking routes. This is qualified at the start of the accounts, and worth repeating for clarity, that these directions give an overview of what is possible, but require further planning by the reader for any such visit. Finally there is a section that presents the etymology of the place names associated with each region, which provides a good link back to the introductory section on the language associated with peatlands.

Yorkshire's peatlands feature strongly in the account and are split across sections on Northern England and the Midlands. There are four detailed accounts that cover the North Pennines, Yorkshire Dales and South Pennines, Humberhead Levels and the Peak District Moors. Given the extent of individual peatlands in Britain and Ireland, and the many important sites and stories associated with them, the author does a great job of selecting a varied range of these to produce a lengthy but not excessive book. It lends itself well to dipping in and out to read site or regional accounts at leisure. It will be of interest to anyone who enjoys peatlands and the countryside in general, either as a reminder of past visits to these famous regions, as inspiration for future trips, or just to enjoy the photographs and discussion of these important regions, and perhaps learn a bit more about them.

Steven Heathcote (*Senior Ecologist at JBA Consulting, with work including peatland survey and restoration throughout the British Isles*).

YNU Calendar 2022

For further details and updates visit the YNU Events Calendar website (https://www.ynu.org.uk/news-events/events).

May	7	Bryological Section, Uldale VC65. Meet at 10:00 am in the lay-by on the A683 just west of Rawthey Bridge, grid ref. SD71209789. Contact: Tom Blockeel (see Card p7).
	7	Botanical Section. Barnburgh, VC63 - Calcareous springs and fens. Meet outside Barnburgh Church. SE484032 at 10.30 am (on-street parking). Contact: Louise Hill (see Card p7).
	21	**VC65 Excursion to Jervaux Abbey Estate.** See p69.
June	4	Botanical Section Marsett Rigg**.** Meet on Marsett Village green SD902862 at 10.30 am. Contact: Linda Robinson (lindarobinson157@btinternet.com). Monitoring Small White Orchids and other interesting limestone flora.
	25	**VC61 Excursion to Leven Canal & Leven Carrs**. See p71.
July	2	Botanical Section. Castleford & New Fryston, VC63. Meet 10:30 am near Play Area off Wheldon Road. SE454629. Contact Kay McDowell (see Card p7).
	9	**VC62 Excursion to Strensall Common**. See p73.
	23	**VC63 Excursion to Brockadale**. See p76.
Aug	14	**VC64 Excursion to Humberstone Bank Farm**. See p77.
Oct	8	Bryological Section, Ogden Clough and Ovenden Moor, VC63. Meet at 10:00 am in the public car park at Ogden Reservoir, SE06593093. Contact: Tom Blockeel (see Card p.7).

Notice: YNU Grant Scheme

The YNU Executive is introducing a grant scheme whereby individuals or organisations can apply for financial assistance to undertake a project which furthers the aims of the YNU. These might include activities like field studies into particular species or habitats, curation of a relevant museum collection or producing material for the development of beginner identification skills. Applications for grants will be considered on a biannual basis. Awarding of a grant will be conditional upon the successful individual or organisation agreeing to give an account of the outcomes of the work, either as a presentation at a YNU conference or an article for *The Naturalist* or both.

For further information and an application form go to the Activities section of the YNU website or contact the Membership Secretary at c/o NEYEDC, 10a Minster Gates, York YO1 7HL (membership@ynu.org.uk).

Yorkshire Naturalists' Union

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Notice to contributors

Contributors should indicate whether they wish their manuscripts to be subjected to anonymous peer review. All other manuscripts will be reviewed by the Editorial Board who at their discretion may send them to third parties for comment and advice.

Original articles should be submitted electronically as an MS Word document to Dr A. Millard at:

editor@ynu.org.uk

Please look at a recent issue of the journal for a general idea of how to present your article. Also see *The Naturalist* - *Guidance for authors* at www.ynu.org.uk/naturalist and please **avoid** the following:

- using any paragraph formatting and line spacings other than single.
- using tabs to tabulate information (please use MS Word table format).
- inserting any figures, graphs or plates into the text; indicate their proposed locations in the text and send them as separate files.

Good quality, high resolution images are very welcome and should be sent as .jpg files, with a separate MS Word file containing the caption and name of the person to whom the image should be attributed.

If electronic submission is not possible, contributions should be sent to Dr. A. Millard, Woodland Villas, 86 Bachelor Lane, Horsforth, Leeds LS18 5NF (Tel. 0113 258 2482).

Contributors should ensure the accuracy of reference citations. The Editorial Board and Council accept no responsibility for opinions expressed by contributors.

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